DOCUMENT RESUME

ED 451 365 CE 081 511

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TITLE Technological Studies at Thomas Edison Middle School. Grades 6-7-8.
PUB DATE 2001-04-20
NOTE 70p.; Developed for Area Cooperative Educational Services (ACES), Northaven, CT.
PUB TYPE Guides - Classroom - Teacher (052)
EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Communications; Course Content; Course Descriptions; Curriculum Guides; *Design; Economics; Engineering; Grade 6; Grade 7; Grade 8; Internet; Learning Activities; Learning Modules; *Manufacturing; Middle Schools; Problem Solving; *Process Education; Research and Development; Science Education; *Technology Education; *Transportation; Units of Study

ABSTRACT

This technology studies curriculum for grades 6-8 is a plan for each middle school student to experience technology education for approximately 60 days (1 trimester of a 180-day school year) in each grade. Section A provides definitions; structure or content for grade-level programs with science and technology unifiers (unifying curricular concepts) identified for each grade; a curricular outline with curriculum overview of each year (technology and science unifiers; performance tasks; unit topics; challenge; weekly outline); and schedule and calendar. Section B contains the curriculum for each of the three grades. Introductory materials for each technology studies curriculum are science and technology unifiers; primary theoretical and activity levels; activity types; technology challenge; vocabulary; schedule; Internet resources; and materials (consumables, reusable supplies, tools and equipment, research resources). Each unit has the following components: technology performance tasks; tech lab basics; schedule; activity (context, chronology, continuation); and extension ideas. Grade 6 units are Problem Solving/Research and Development; Materials and Processes; and Engineering Design. Grade 7 units are Transportation Systems; Communications Systems; and Production Systems. Grade 8 units are Enterprises and Agencies; Technology and Economics; and Technological Impacts. Appendixes include a glossary; curriculum crosswalks; general safety guidelines; and reference texts. (YLB)

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Technological Studies

at Thomas Edison middle school

developed for

aces

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grades 6–7–8

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Thomas Edison Technological Studies 6–8

This is a technology studies curriculum for grades six through eight. It is a plan for each middle-school student to experience technology education for approximately 60 days (one trimester of a 180-day school year) in each of the three grades at the Thomas Edison Middle School in Meriden, CT.

This curriculum also provides for a major ***technology challenge*** *to be issued to the students in each grade every school year.*

Context

Definition of terms. At the onset it is important to define terms which will be used throughout this document. For the purposes of this curriculum,

Technology refers to the changes made by human beings to the natural environment.

Technology education is that branch of pedagogy that focuses on learning about technology, its constituent parts, its systems, and its impacts on people and the environment.

Science education is that branch of education that focuses on learning about the natural environment and its systems, and the interrelations among those systems.

Social studies is education about people and the relationship between groups and individuals, as well as the interactions among people and their environment. Thus technology education is a social study.

Value of integrated education. It is assumed that education about people (social studies) and their environment (science education) are best introduced to students in an integrated manner. Thus the units and activities encourage learning about people and their technology in the context of the natural environment whenever possible.

Structure/content for grade-level programs

A **science unifier** and a **technology unifier** have been identified for each grade. The term *unifier* here is short for *unifying curricular concept*. For example, in grade six, three science content units focus on the physical and earth sciences; thus, although the life sciences and chemistry are included in the grade-six curriculum, *Physical and earth sciences* has been identified as the **science unifier**.

The following are the themes of the school's science content units.

Grade 6	Earth Science	Space; Physics	Physics; Chemistry	Life Science
Grade 7	Biology; Environment	Genetics	Chemistry; Earth Science	Earth Science; Chemistry
Grade 8	Earth Science/ Weather	Chemistry	Life Science; Human Body	Nature of Science

In grade seven the science unifier has been identified as *life sciences and chemistry*, as these are the dominant content areas at this grade level. The grade eight curriculum contains roughly equal measures of chemistry and the life and earth sciences, as well as a unit on the nature of science. For grade eight the science unifier has been identified as the *integrated study of science.*

Grade	Science Unifier
6	*physical and earth sciences*
7	*life sciences and chemistry*
8	*integrated study of science*

Science unifiers have been identified for the purpose of the selection of **technology unifiers**.

Technology unifiers

Three technology unifiers have been identified: design, systems, and impacts. Just as the combination of physical science, life science, and chemistry represents the common areas of scientific study, but does not encompass all aspects of science, the design-systems-impacts scheme represents the important areas of technology to be investigated at the middle-school level.

Every successful technological undertaking in our society can be viewed to include three important *technological actions*: *planning*, *building*, and *evaluating*. These three actions are the *verbs* that correspond to the *nouns* of the technology unifiers:

Verb **(technological action)**	**Noun (technological unifier)**
Plan	Design
Build	Systems
Evaluate	Impacts

An architect *plans* a house (produces a *design*); a general contractor supervises the *building* of the house from the architect's blueprints (oversees the construction of the house's *systems* such as structure, electrical, plumbing, etc.); and an inspector *evaluates* the house (to ensure, for instance, that the electrical wiring will not have adverse *impacts* on the safety of the house). Of course, this is a simple example. In the process of *planning*, the architect may *build* a model of the house, or have her or his blueprints *evaluated* by a supervisor.

Or take, if you will, the case of an airline hoping to add a new city to its feature destinations. Before this can become a successful undertaking, airline managers must first *plan* a service schedule for the new city. Then they must *build* the schedule, taking into consideration existing flights, personnel, equipment, competition, and the like; and then *evaluate* the new schedule, either by running a computer simulation, or monitoring the actual operation of the schedule once it is implemented. In this case, the initial plan for the new service is the *design* of the technological undertaking. The schedule itself is the *system* that is being developed—a subsystem that must work within the larger system of the airline's complete service. Finally, the success of the new service is its *impact* on the company's finances and reputation—and in this example the planners of this schedule must also consider the impact establishing this new service will have on its other routes, on employee relations, on stock prices, and on the business as a whole.

Having engaged in a curriculum based on these notions, students will complete eighth grade with an *understanding* of technological design, systems, and impacts through their participation in the *activities* of planning, building, and evaluating.

A technology unifier has been paired with each grade-level science unifier:

Grade	Science Unifier	Technology Unifier
6th	*physical and earth sciences*	Design
7th	*life sciences and chemistry*	Systems
8th	*integrated study of science*	Impacts

Although several other assignment combinations would also have made sense, this combination pairs the most integrated technology unifier, *impacts*, with the *integrated study of science* unifier. Impacts are studied in eighth grade, after a technological foundation has been formed.

Curricular structure

Connecticut Technology Education Standards (1998). The Connecticut Department of Education has issued a Technology Education Framework. The framework is comprised of eleven *content standards*:

1. Economics
2. Technological Impacts
3. Career Awareness
4. Problem Solving/ Research and Development
5. Leadership
6. Materials and Processes
7. Communications Systems
8. Production Systems
9. Transportation Systems
10. Enterprise
11. Engineering Design

Each content standard is further subdivided into *performance measures*. There are nearly one hundred performance measures.

Each technology unifier in the Thomas Edison Technological Studies curriculum has then been associated with several standards from the Connecticut Technology Education Framework (1998):

Grade	Science Unifier	Technology Unifier	Applicable CT Tech content standards	
6	*physical and earth sciences*	Design	4, 6, 11	} 3, 5
7	*life sciences and chemistry*	Systems	7, 8, 9	
8	*integrated study of science*	Impacts	1, 2, 10	

The *career awareness* (CT Standard 3) and *leadership* (CT Standard 5) content standards are not associated with a single technology unifier. Their performance standards, however, will be achieved not only through several technology activities, but by the school's Microsociety program as well.

Students at each grade level will be issued a *technology challenge*. This challenge will be preceded during the year with three technology units per level. Students will apply knowledge from these activities when meeting the challenge.

	science unifier / **technology unifier**	Technology Challenge
grade 6	*physical and earth sciences* / **design**	Design and build a scale representation of an extraterrestrial settlement.
grade 7	*life sciences and chemistry* / **systems**	Identify the transportation, communication, and other physical needs of a modern community. Plan and create a model of an integrated modern community, employing concepts of producing, communicating, and transporting.
grade 8	*integrated study of science* / **impacts**	Investigate and document a real technological problem in the community. Develop, model, and present a solution to one or more appropriate agencies. If appropriate, implement the solution.

Each year students will be expected to become increasingly interdependent on each other. The final technology challenge of middle school is designed allow the teacher to require the cooperation of all eighth grade students. A technological problem will be identified (pollution, traffic, animal habitat reduction, overuse of resources such as water or electricity, waste management, recycling, etc.) and the class will be organized to address the problem and develop several solutions, one of which will ultimately be presented to appropriate governmental or corporate agencies.

Curricular Outline

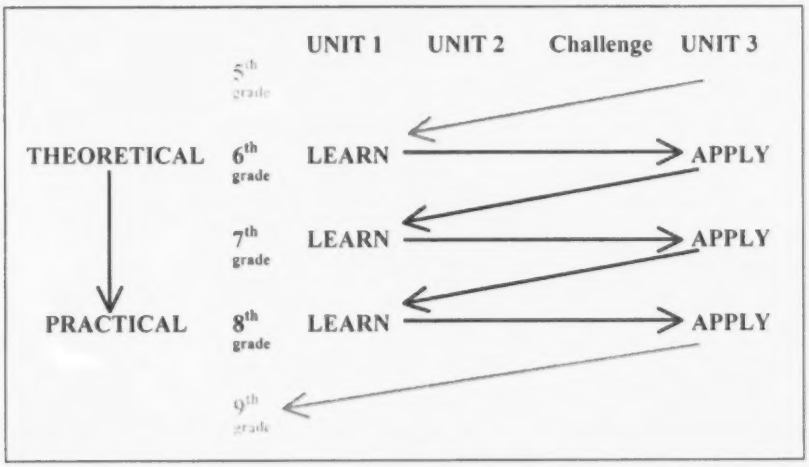
Progression of technological knowledge and abilities from grade six through eight

Although this curriculum represents an attempt at "real-world" learning, at its start in the beginning of grade six it is much more theory-focused than it is at the end of the grade eight.

For example, the final challenge for sixth-graders and the final challenge for seventh-graders have superficial similarities, as the product of each is a model of a community. But the projects are very different. Whereas sixth-graders employ their current base of knowledge with newly learned design, problem-solving, and creativity techniques to design theoretical communities on far-off planets, seventh-graders apply their knowledge of technological systems to model a modern community, learning along the way the interdependence of transportation, communication, and production systems. Armed with an increased understanding of the technological underpinnings of their locality as well as the world, eighth-graders identify and address real-world technology problems in their communities. Thus the recurrent *community* device is "spiraled" through the curriculum, reappearing throughout a student's three-year technology experience.

The other spiraled device in this curriculum is the "Tech Report." Producing a high-quality written document as a part of technological studies is emphasized each school year.

Each school year, students gain knowledge and technological competence that they apply when facing a technology challenge. In addition, each year's prior challenge prepares students for the next challenge.



Curriculum overview

The curriculum is designed so that each grade will start and end major activities at nearly the same time. It should be easy to schedule the grade 6, 7, and 8 challenges to take place at the same time; thus students in all three grades may be working on their "grade challenges" projects in parallel. The grade 6, 7, and 8 challenges are scheduled to begin about halfway through each term. This should allow for these projects to extend beyond three school weeks if necessary. In such cases, the final unit would have to be shortened (or perhaps combined in some way with the major project.)

The following is an overview of each year of the curriculum. The intent of these sections is to lay out teaching and learning expectations at each grade level.

Grade Six Overview

Technology Unifier: Design
Science Unifier: Physical and earth sciences

Performance task	Unit during which task is introduced
Needs identification	6-1
Environmental survey and consideration	6-1
Draft basic blueprint plans	6-1, 6-2, 6-3
Materials selection	6-2
Building and inspecting	6-2, 6-3
Collection of feedback data	6-3
Expansion and redevelopment based on feedback	6-3
Report findings	6-1, 6-3

UNIT 6-1: Problem-Solving/ Research & Design
- Problem-solving identification and terminology
- Constraints of problem-solving
- Applied Research
- Real-life problems and solutions

UNIT 6-2: Materials and Processes
- Types and uses of materials
- Layout and shaping
- Assembly and finishing techniques
- Troubleshooting and testing

Grade Six Challenge: Design and build a scale representation of an extraterrestrial community.

UNIT 6-3: Engineering Design
- Elements of electronics-engineering design
- Brainstorming, creativity, creativity enhancement
- Basic schematic sketching
- Production layout

WEEK 1 — INTRODUCTION ..... 5 days
Safety and group-work exercises introduce students to the environment and procedures of the Tech Lab. Plans for the 12-week term are explained to the students.

WEEKS 2-3 — UNIT 6-1: Problem-Solving/Research & Development ..... 10+ days
Students are given problem to solve. The solution will be developed in small groups using limited resources and observing specified design constraints.

WEEK 4 — CATCH-UP & TECH REPORT
The first few days of this week should be used to wrap up Unit 6-1, including the writing of the Tech Report. The last one or two days of this week should be used to introduce Unit 6-2. Because the grade six challenge needs to begin on the first day of week 7, Unit 6-2 must be completely finished by the end of week 6.

WEEKS 5-6 — UNIT 6-2: Materials and Processes ..... 10+ days
Students are given multiple materials with which to complete a constrained, open-ended task. They must research and experiment with the materials and build and test a solution.

WEEKS 7-8 — GRADE SIX CHALLENGE ..... 10+ days
The sixth-grade challenge is to design and build a scale representation of an extraterrestrial community.

WEEK 9 — CATCH-UP
This week allows extra time to complete the grade six challenge. The last day or two of this week should be used to introduce Unit 6-3. If time permits, an enrichment activity can be undertaken.

WEEKS 10-11 — UNIT 6-3: Engineering Design ..... 10+ days
Students design and build a functioning electronic system.

WEEK 12 — WRAP UP ..... 5 days
A day or two can be used to wrap up Unit 6-3. The remainder of this week should be used to review the 12-week term, to restore the laboratory, and to introduce students to next year's activities.

Grade Seven Overview

Technology Unifier: Systems
Science Unifier: Life sciences and chemistry

Performance task	Unit during which task is introduced
Identification of transportation needs	7-1
Identification of communication needs	7-2
Develop and plan isolated transportation and communications routes and systems	7-1, 7-2
Identification of material needs	7-1, 7-2, 7-3
Plan, test, and troubleshoot integrated systems	7-1, 7-2, 7-3
Model complete system	7-3
Produce a technical report	7-1, 7-3

UNIT 7-1: Transportation Systems
- Transportation classification, terminology
- Transportation design: propulsion, control, etc.
- Modes of transport: marine, space, land, air

Maintenance, scheduling in transportation systems

UNIT 7-2: Communications Systems
- Communications terminology; mass, interpersonal
- Acquiring and applying electronic information
- Design of communication systems
- Integration of communication and production

Grade Seven Challenge: Identify the transportation, communication, and other physical needs of a modern community. Plan and create a model of an integrated modern community, employing concepts of producing, communicating, and transporting.

UNIT 7-3: Production Systems
- Production terms; craft, line assembly, automation
- Methods, tools, materials in manufacturing
- Model design and realization
- Basic production organization and sequencing

WEEK 1 — REVIEW ..... 5 days
Students review learning, activities, and procedures from Grade 6. The Grade 7 agenda will be introduced, and students will engage in three one-period activities designed to prepare them for Units 7-1, 7-2, and 7-3.

WEEKS 2-3 — UNIT 7-1: Transportation Systems ..... 10+ days
Students design and construct working models of land and marine vehicles.

WEEK 4 — CATCH-UP & TECH REPORT
If needed, a day or two of this week can be used to complete the transportation unit or provide extra time for Tech Report work. The end of this week should be used to introduce or begin the communications unit (7-2).

WEEKS 5-6 — UNIT 7-2: Communications Systems ..... 10+ days
Students survey and map the physical plant of the school. (Because the grade seven challenge needs to begin on the first day of week 7, Unit 7-2 should be finished by the end of week 6.)

WEEKS 7-8 — GRADE SEVEN CHALLENGE ..... 10+ days
The challenge is to identify the transportation, communication, and other physical needs of a community, then create an integrated model of modern community.

WEEK 9 — CATCH-UP
This week allows extra time to complete the grade seven challenge. The last day or two of this week should be used to introduce Unit 7-3.

WEEKS 10-11 — UNIT 7-3: Production Systems ..... 10+ days
Students plan and implement an assembly line to mass-produce a product.

WEEK 12 — WRAP UP ..... 5 days
If the students are not finished with performing the tasks of Unit 7-3, including the Tech Report, the first day or two of week 12 may be used to complete this unit. The remainder of this week should be used to review the 12-week term, to restore the laboratory, and to introduce students to next year's activities.

Grade Eight Overview

Technology Unifier: Impacts
Science Unifier: Integrated study of science

Performance task	Unit during which task is introduced
Problem identification	8-1, 8-2
Investigation and research	8-1, 8-2
Documentation of a technological problem	8-1, 8-2, 8-3
Development of possible solutions	8-3
Solution refinement and modeling	8-3
Presentation of solution	8-3
Development of a final report	8-1, 8-3

UNIT 8-1: Enterprises and Agencies
- Evolution, classification of enterprise
- Organization of enterprises
- Market and customer research
- Labor and management roles

UNIT 8-2: Economics
- Economics, politics, and technology
- Societal use, distribution of resources
- Consumer demands and decisions
- Global market economy, local and tech. effects

Grade Eight Challenge: Investigate and document a real technological problem in the community. Develop, model, and present a solution to one or more appropriate agencies.

UNIT 8-3: Technological Impacts
- Expected, unexpected, wanted, unwanted effects
- Input-Process-Output-Feedback model
- History, impacts of automation and miniaturazation
- Personal, societal, economic, environmental impacts

WEEK 1 REVIEW ..... 5 days
Students should review learning, activities, and procedures from Grades 6 and 7. Students will engage in brief activities designed to prepare them for grade 8 technology units.

WEEKS 2-3 UNIT 8-1: Enterprises and Agencies ..... 10+ days
Students begin to identify and analyze technological enterprises.

WEEK 4 CATCH-UP & TECH REPORT
Students may require some extra time to wrap up Unit 8-1 and to complete their Tech Reports. The teacher may engage the students in extension activities. The end of this week should be used to introduce (and, if possible, begin) Unit 8-2. Because the grade eight challenge needs to begin on the first day of week 7, Unit 8-2 must be completely finished by the end of week 6.

WEEKS 5-6 UNIT 8-2: Economics ..... 10+ days
Select a technological problem to investigate and schedule their inquiry.

WEEKS 7-8 GRADE EIGHT CHALLENGE ..... 10+ days
The grade eight challenge is to investigate and document a real technological problem in the community and to develop, model, and present a solution to one or more civic agencies.

WEEK 9 CATCH-UP
This week allows extra time to complete the grade eight challenge. The last day or two of this week should be used to introduce the next unit.

WEEKS 10-11 UNIT 8-3: Technological Impacts ..... 10+ days
Students document the problem they investigated and identify its impacts.

WEEK 12 WRAP UP ..... 5 days
This week can be used to allow students extra time to work on their Unit 8-3 Tech Reports. The final week of their middle-school technology education should also be used to review what was learned during middle school and to introduce students to further technology-education options in high-school education.

Schedule and Calendar

Each student will experience technology education for one-third of each school year: approximately 12 weeks, or 60 days. The following is an overview of the calendar, which can repeat three times during the school year (e.g., August, November, and February).

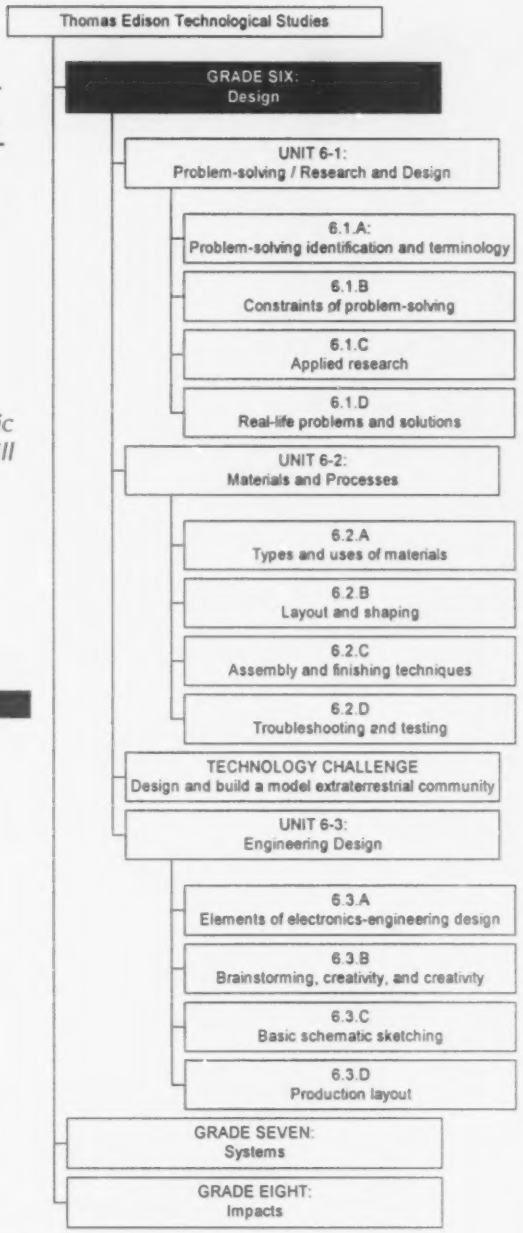
The time allotted for each unit is the **minimum** amount of time the activity should require.

week #	day #	grade 6	grade 7	grade 8
1	1 2 3 4 5	**INTRO** (5 Days)	**REVIEW** (5 Days)	
2	6 7 8 9 10	**UNIT 6-1:** Problem-solving/ Research and Development (10 Days)	**UNIT 7-1:** Transportation Systems (10 Days)	**UNIT 8-1:** Enterprises and Agencies (10 Days)
3	11 12 13 14 15			
4	16 17 18 19 20			
5	21 22 23 24 25	**UNIT 6-2:** Materials and processes (10 Days)	**UNIT 7-2:** Communications Systems (10 Days)	**UNIT 8-2:** Economics (10 Days)
6	26 27 28 29 30			
7	31 32 33 34 35	**TECHNOLOGY CHALLENGE** (10 Days)		
8	36 37 38 39 40			
9	41 42 43 44 45			
10	46 47 48 49 50	**UNIT 6-3:** Engineering Design (10 Days)	**UNIT 7-3:** Production Systems (10 Days)	**UNIT 8-3:** Technological Impacts (10 Days)
11	51 52 53 54 55			
12	56 57 58 59 60	**WRAP UP** (5 Days)		

Each "gray area" in this schedule is a five-day period set aside to wrap up the prior activity, account for days lost to school activities or cancellations, introduce enrichment activities, or get a head start on the next unit.

Grade Six Technological Studies Curriculum Structure

Science Unifier: Physical and earth sciences
Technology Unifier: Design
Primary Theoretical Level: THEORY
Primary Activity Level: PRACTICE
Activity types: Most grade six activities have a strong hands-on component as well as focusing on content acquisition. The grade six technology challenge is primarily constructional.
Technology Challenge: Design and build an extraterrestrial settlement.



In addition to content learning and task mastery, throughout grade six students will be introduced to basic concepts of technology, group work, and safety, and will become familiar with laboratory and classroom procedures. These goals are listed as "Tech Lab Basics."

Vocabulary

alternatives
brainstorming
communications
energy
feedback
information
input
machines
manufacturing
mass production
material
model
output
problem solving
research
resources
resources
subsystem
system
technology
trade-off
trial and error

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GRADE SIX SCHEDULE

DAY 1—Orientation to the course: Student seating; introduction of teacher; introduction of material
DAY 2—Partnership skills; lab overview (part I).
DAY 3—Lab overview (part II); safety exercise
DAY 4—Teambuilding activity
DAY 5—Identification: technology and science

DAYS 6-20—Unit 6-1 (page B-4).
DAYS 21-30—Unit 6-2 (page B-7).
DAYS 31-45—Grade Six Challenge (page B-10).
DAYS 46-55—Unit 6-3 (page B-12).

DAY 56, 57, 58—Tech Report: students record their experiences in building the security and intercom systems in a tech report, which describes and compares the two activities.
DAY 59, 60—Catch-up time, lab restoration, etc.; end of term.

INTERNET RESOURCES

These web sites contain lesson plans or other resources that relate to the content of the grade six curriculum.

dozens of general technology activities are available at
http://www.teched.mankato.msus.edu/TLA/GenTechTLA.html
this site contains several two-dimensional art/design projects which might be suitable enrichment activities:
http://7-12educators.about.com/education/7-12educators/msub1plnfineart2d.htm
the following site has a scientific treatment of paper-airplane aerodynamics:
http://www.geocities.com/CapeCanaveral/1817/paero.html
there are many sites out there with paper airplane designs. This is the best and most scientific:
http://www.paperairplanes.co.uk
another good resource for homemade-airplane designs, as well as other elementary activities is
http://www.exploratorium.edu/exploring/paper
Exploratorium.edu also has a space-science page
http://www.exploratorium.edu/exploring/space
NASA spacelink has a lot of age-appropriate science and technology activities:
http://www.spacelink.nasa.gov

GRADE SIX MATERIALS

The tools and materials needed for units 6-1, 6-2, and 6-3 are listed below. The encircled numbers following each item indicates the unit in which it is used; ① indicates unit 6-1, ② indicates unit 6-2, etc.

Consumables:

- ❑ scrap letter-sized paper (①: 10 sheets per student) ②
- ❑ ¼" square strips of wood (pine is recommended): approximately 3' per student ①
- ❑ glue (white or aliphatic) ①
- ❑ tape (clear or masking) ①
- ❑ wax paper ①
- ❑ used manila folders (one for every four students) ①
- ❑ ¼" graph paper: 3-4 sheets per student. ①
- ❑ balsa wood in the following sizes (per student):
  - ❑ 3/16" x 2" ②
  - ❑ 3/16" x 1/2" ②
  - ❑ 1/16" x 1-1/2" ②

Consumables, con't

- ❑ electrical tape ②③
- ❑ thin sheet metal, 3 in² per student ②
- ❑ hot glue ②
- ❑ work surface for cutting ③
- ❑ breadboard and components:
  - ❑ lamps ③ ❑ buzzers ③ ❑ switches (on-off, push-to-make, and toggle) ③
  - ❑ 9V battery clips ③
- ❑ 9V batteries or DC power supply ③
- ❑ solder ③
- ❑ medium or large file cards (3 per student) ③
- ❑ adhesive copper tape ③
- ❑ transparent plastic grid material ③
- ❑ enameled copper magnet wire, 22 gauge, single-strand ③

Reusable supplies:

- ❑ sandpaper (①②: at least two grit sizes) (③: high-grit)
- ❑ steel wool ②

Tools and equipment:

- ❑ wood or heavy cardboard work surface ①
- ❑ triple-beam science scale ①
- ❑ bathroom scale ①
- ❑ heavy-duty bucket ①
- ❑ any items or substance of uniform weight (water, sand, certified weight set, etc.) ①
- ❑ stationary electric "scroll" (reciprocating) saw; saw blades ①②
- ❑ backsaw ①
- ❑ 45°/90° miter box. ①
- ❑ sturdy work surface with vises ②
- ❑ tape measure (at least 25') ②
- ❑ scissors ②
- ❑ pencils ②③
- ❑ tin snips ②
- ❑ metal file ②
- ❑ pliers ②③
- ❑ tin snips ③
- ❑ X-Acto knife ③
- ❑ safety rule ③
- ❑ soldering iron ③

Research resources (library should be used if available):

- ❑ computers with internet access and word processing software ①
- ❑ printers (accessible from computers); printer supplies (toner, paper, etc.) ①
- ❑ wing and fuselage patterns (from texts or http://www.nasa.gov) ②
- ❑ print resources (books, magazines, etc.) ①②③
- ❑ schematics ③

UNIT 6-1: PROBLEM-SOLVING / RESEARCH AND DESIGN

In this unit, students will be introduced to the design process as a means of addressing human wants and needs. They will design and test a model bridge, calculate its efficiency, and redesign based on the feedback they receive. They will begin to use orthographic projection to produce technical drawings. They will also produce their first "tech report."

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Identify needs, Test and calculate efficiency, Draft basic blueprint plans, Report findings

➢ **TECH LAB BASICS:**

Organization of the class and the laboratory, General laboratory safety practices and procedures

➢ **SCHEDULE:**

DAY 6—**Instruction**: definition of a problem; of problem-solving. Strategies in problem-solving. students identify human needs, wants, and problems, and describe ways of addressing them using technological solutions. *<6.1.A. Problem-solving identification and terminology>*

DAY 7—**Instruction**: design constraints; design and terminology of bridge engineering. **ACTIVITY➔** bridge structure/design. Students are given materials with which to build a bridge that can hold a minimum mass. *<6.1.B. Constraints of problem-solving>*

DAY 8, 9, 10, 11—**ACTIVITY➔** bridge structure/design, continued. In groups, students are challenged to design the most efficient (i.e., best structure capacity-to-structure mass ratio) bridge within certain constraints. Testing, feedback, and redesign exercises are used to calculate and improve efficiency. *<6.1.C. Applied Research>*

DAY 12—**Instruction**: basic orthographic projection. **Instruction**: conducting research on the internet (if available; otherwise, conducting research via print materials.) *<6.1.D. Real-life problems and solutions>*

DAY 13, 14, 15—**ACTIVITY➔** students use basic orthographic projection to accurately depict the design of their group's bridge.

ACTIVITY➔ students use the internet and/or print material to gather information about real-life engineering problems and solutions.

****These exercises should be done simultaneously: some students will be conducting research while others are drafting their plans. This should allow students to rotate through computer stations if not enough computers are available for each student to use one. These exercises may be done in the tech lab, or in the library or computer lab.****

DAY 16, 17, 18—**TECH REPORT➔** students prepare a brief tech report/portfolio which identifies the problem and the process and design of the solution.

DAY 19, 20—**Catch-up time**.

ACTIVITY

➢ **CONTEXT:**

In this activity, students build a bridge that can hold a minimum mass, using given materials.

Background information: problem-solving; design constraints; bridge terminology.

Safety needs: all students will need safety glasses and training on using glue, the scroll saw, and any other equipment used. Smocks or lab aprons should be available.

Cleanup needs: dustpans and handbrooms or a hand-held vacuum cleaner for sawdust; warm water and soap for glue.

➢ **CHRONOLOGY:**

STEP 1: Divide students into groups of two or three.

STEP 2: Tell the students that they will first use paper to test various bridge designs.

STEP 3: Distribute two pieces of scrap paper to each group and instruct them to experiment with shaping the paper so that it can suspend lightweight objects such as pencils, paper clips, etc. Do not discourage students from "spying" on other groups to get good ideas.

STEP 4: After the students have experimented for a few minutes, provide the students with the following guidelines for the design and construction of a "test bridge" made out of paper:

* the bridge must be at least 2" tall.
* the bridge must span at least 5" (e.g., between two desks or stacks of books).
* only provided paper may be used as a building material.
* tape may be used only for joining pieces of paper.
* the bridge must be free-standing.
* you may not prevent other groups from seeing your design!

STEP 5: Briefly demonstrate how bridge efficiency is measured: by dividing the mass the bridge can hold up by the mass of the bridge itself.

STEP 6: Provide students with additional paper and tape and have them begin construction.

STEP 7: Each group should test their bridge, record the results, and reconstruct/retest at least three times.

STEP 8: In their journals, students should record the following information:

Trial #	BEST	mass the bridge can hold	mass of the bridge	efficiency = mass the bridge can hold ÷ mass of the bridge
1	❑			
2	❑			
3	❑			
4	❑			
5	❑			

STEP 9: After the students have tested and improved their paper bridge designs, tell them that it is time for them to build more realistic bridges using wood for the trusses and manila folder material for the gussets. The design specifications are as follows:

* The bridge must be at least 4" tall and span at least 10".
* Only provided wood strips may be used as trusses.
* Only provided file folders may be used as gussets.
* Gussets may be no more than 1 in^2 in size.
* The bridge must be free-standing.
* You may not prevent other groups from seeing your design.

STEP 10: Demonstrate this procedure for making a wood-truss to the students:

* Use graph paper to make a full-sized drawing of the bridge.
* Get the design approved by your teacher before proceeding.
* Use the drawing to lay out the correct lengths and angles for your trusses.
* With the approval of your instructor, begin cutting the trusses. Overcut by no more than ¼".
* Lay the cut trusses on the drawing to ensure proper cuts.
* Use sandpaper to make fine adjustments to the lengths and angles of the trusses.
* Cut uniform trusses out of the file folders (two per joint).
* Place wax paper over your drawing; then place one (inside) gusset at each joint.
* Put glue on each gusset and carefully assemble one side of the bridge.
* Finish the side of the bridge by placing an outside gusset at each joint.
* Make the other side of the bridge and the bottom following this procedure.
* Assemble the bridge.
* Test the bridge's efficiency and record the results; reconstruct and retest at least two more times.
* Record all results in your journal.

➢ **CONTINUATION:**

Students should write a tech report detailing their work on the bridge project. They will already have data that they have collected which should allow them to draw conclusions, as well as other notes and drawings. Each report should contain the following information: Statement of Purpose (or Problem); Methods; Illustrations; Results (or Data); and Conclusions.

DEFINING TECHNOLOGY...a discussion-based activity that can be accomplished in half of a period, **this exercise engages the class in a conversation about the identity and nature of technology**. To begin with, what *is* technology? The teacher can pose this question and help students arrive at the notion that technology is essentially anything human-made. This can be followed by defining the terms *product*, *mass-production*, and *process*. How has technology evolved since the students' parents were in school? What changes have occurred in sports, transportation, entertainment, medicine, and communication? It may be helpful to have students identify items in the classroom—other than themselves—which are *not* products of technology!...

TECHNOLOGY TIMELINE...this activity requires student access to magazine pictures that they can cut out, or a photocopier and access to photographs, clip art, etc. The internet can be a good source of pictures as well. This project will take some advance planning or homework, but can then be accomplished in less than two periods. Students will **use images to create a timeline showing the evolution of a specific technology**. This technology can be as broad as the teacher allows (transportation, miniaturization, etc.), or quite specific; e.g., personal transportation, music recording, or sports equipment. C-sized drafting paper or poster board is the perfect size for this activity...

In this unit, students will begin to consider the properties of materials in their selection during design. They will also be introduced to some simple material processes, such as layout, separating (cutting) and shaping. After exploring the principles of flight, they will design, test, and redesign an aerodynamic glider.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Draft basic blueprint plans, Materials selection, Construction and inspecting

➢ **TECH LAB BASICS:**

Introduction to concepts of resources, Practice working in pairs and small groups

➢ **SCHEDULE:**

DAY 21—**Instruction**: types of resources; introduction to identification and processing of materials. Introduction to the scroll saw and related safety. *<6.2.A. Types and uses of materials>*

DAY 22—**Instruction**: basics of aerodynamics: drag, lift, thrust, weight. Orientation to glider activity.
Demonstration: use of the scroll saw. *<6.2.B. Layout, and shaping>*

DAY 23—**ACTIVITY**➔ glider construction. In pairs or singly, students follow directions to begin the construction of a simple balsa-wood glider.
Demonstration: sanding and assembly. *<6.2.C. Assembly and finishing techniques>*

DAY 24, 25, 26—**ACTIVITY**➔ glider construction, continued. Students lay out, cut, sand, and assemble their balsa-wood gliders.

DAY 27—**Instruction**: testing and adjusting aerodynamic characteristics and their impacts on flight patterns. *<6.2.D. Troubleshooting and re-testing>*
Demonstration: flight pattern recording.

DAY 28, 29—**ACTIVITY**➔ identify and record flight patterns of the glider; test and adjust its aerodynamic properties; re-test to achieve desired pattern; re-record results.
ACTIVITY➔ (if time) students begin to present their gliders.

DAY 30—**ACTIVITY**➔ glider presentation. Class discussion.

ACTIVITY

➢ **CONTEXT:**

In this activity, students construct gliders and test and modify their aerodynamic properties.

Background information: resources; identification and processing of materials; aerodymanics terminology.
Safety needs: all students will need safety glasses and training on using the scroll saw and any other equipment used.
Cleanup needs: dustpans and handbrooms or a hand-held vacuum cleaner.

➢ **CHRONOLOGY:**

STEP 1: If time permits, hand out scrap paper for students to experiment with folding traditional "paper airplanes." Be certain that students are able to modify their designs to affect the lift, drag and weight of the planes.

STEP 2: Point out that making adjustments to the aerodynamic properties of planes is easier if sturdier materials and adhesives are used. Explain that they will use balsa wood to build planes on which they can experiment with adjusting these properties.

STEP 3: Orient students to the specific uses of each size of balsa wood.

STEP 4: Demonstrate this procedure for building the gliders:
* Cut all patterns out with scissors.
* Trace the **fin** and **stabilizer** patterns on to the 1/16" x 1-1/2" material.
* Cut out the fin and stabilizer using a scroll saw; label and initial each in pencil.
* Trace the **wing** patterns on to the 3/16" x 2" material; cut out, label, and initial.

* Trace the **fuselage** pattern on to the 3/16" x 1/2" material; cut out, label, and initial.
* Use sandpaper to shape the fuselage and wings.
* Carefully assemble the wings by gluing them at as close to a 30° angle as possible.
* Attach the fin and stabilizer.
* Attach the wings to the fuselage.
* Assemble the tail section to the body of the plane.
* With instructor's permission, test-fly the plane.

STEP 5: Instruct students in the use of sheet metal and tools for cutting and shaping a nose weight.

STEP 6: Provide each group with time and space for at least three test flights. In their journals, students should record the exact adjustments they made in attempting to affect the glider's lift, drag, thrust and weight, and the results achieved.

STEP 7: Provide each group with three "official" flights. Students must record the distance of each flight and any additional adjustments they made to the plane.

STEP 8: Demonstrate the effect control surfaces (ailerons, elevators, horizontal stabilizers, rudders, and vertical fins) have on the flight of an airplane. This is probably best demonstrated using a simple, folded-paper airplane. Show students how the ailerons and elevators can be used to make the plane go up or down; and how the rudder can make the plane turn. On an actual airplane, all control surfaces are able to be moved; they pivot to allow for adjustments in flight.

STEP 9: Hand out more scrap paper for students to experiment with folding airplanes. This time, they should cut flaps to imitate elevators and ailerons. Be sure they can demonstrate their understanding of control surfaces and how they can be adjusted to alter the flight of a plane.

STEP 10: Challenge the students to apply their new knowledge of control surfaces by cutting ailerons and elevators out of their balsa-wood planes and using electrical tape to adjust them. Once they have done this to your satisfaction, they may experiment with adjusting the stabilizer, fin, and rudder.

STEP 11: Students should be provided with time and space to conduct "test flights" to improve their command of control surfaces. At a minimum, they should be able to consistently make their planes head right, left, down, or up, without substantially affecting the distance the plane can fly.

STEP 12: Students should record each adjustment they make, along with its result, in their journals.

➢ **CONTINUATION:**

Students access model plans on the internet and build models according to specifications. If additional time is available, students may access the NASA website (www.spacelink.nasa.gov) and download and print out plans for the construction of models of spacecraft, observatories, and satellites. To complete the project, students should research information on the model they have built and provide a brief report on its purpose, construction, and current status.

EXTENSION IDEAS FOR UNIT 6-2

NONVERBAL COMMUNICATION...students begin this activity by identifying common universal symbols and their meanings: the red octagon meaning "stop," as well as other traffic signals; transportation-terminal signs ranging from stylized images of planes to the "man" and "woman" images on restroom doors; the universal symbols for various Olympic sports; and others. This should lead in to a discussion of the many words and ideas that do not have accepted symbols. The challenge for students in this activity is to **convey a message to another group without using words or numbers**. Each group is assigned (a) a short message to communicate and (b) another group to communicate the message to. The "sending group" must communicate the message across the room by using symbols that in no way rely upon written or spoken language (numbers included). The teacher or a member of a third team relay the symbols to the "receiving" group. The receiving team writes down their best interpretation of the message, and this interpretation is ultimately compared with the original message. Some ideas for messages are RUN AWAY: DANGEROUS DOG; WE'RE THIRSTY: PLEASE SEND WATER; and MY CANDY STORE—DO NOT ENTER! It may be helpful to remind the students that the *idea*, not the exact words, must be conveyed in the message...

LEGO MASS PRODUCTION...this exercise exposes students to the importance of following directions and quality control in materials-handling and manufacturing. In this activity, students **use an assembly line to accurately assemble a specific quantity of products made from Legos** or a similar modeling system. The class is divided into four teams: three assembly lines, and one group of quality-control checkers. (If desired, four or

five assembly groups can be formed, although it is best to have at least two checkers in the quality control group for each assembly team.) The teacher presents a Lego model to representatives from each assembly team, and the teams begin to mass-produce copies of the model. The Lego model should be difficult enough so that it takes some attention to create the first time, but simple enough to replicate so that each group can develop a means of assembling it which takes advantage of the skills of the people in the group. The quality control checkers should be in charge of helping the group assemble the products accurately. If some orientation time is spent the day before, this can be a one-period activity, with a review the next day. It is this review which probably will provide for the richest learning…

GRADE SIX CHALLENGE

The grade six challenge is to design and model an extraterrestrial settlement. Below are some ideas that might aid the teacher in providing a meaningful fifteen-day activity.

➢ SCHEDULE:

DAY 31—**Discussion**: functions and typical layouts of communities; community basics: transportation, communication, etc. ACTIVITY➔ community design ideas.
DAY 32—**Instruction**: basics of community design; extraterrestrial environments. ACTIVITY➔ design considerations in extraterrestrial environments.
DAY 33, 34, 35, 36, 37—ACTIVITY➔ Part I: design and modeling an extraterrestrial settlement.
DAY 38—**Discussion**: Community-needs assessment; analysis of challenge vs. solution. ACTIVITY➔ continue Activity Part I if needed.
DAY 39, 40—ACTIVITY➔ Part II: community assessment redesign, and maintenance.
DAY 41—**Demonstration**: presenting a community plan to potential community members.
ACTIVITY➔ continue Activity Part II if needed.
DAY 42, 43—**Student presentations**.
DAY 44, 45—**Catch-up time**.

ACTIVITY

➢ CONNECTIONS:

In this activity, students will apply problem-solving, research, and design skills they acquired in Unit 6-1, along with their knowledge of materials and processes from Unit 6-2. It is important to reinforce that these are two of the three basic tasks that make up this challenge: (1) design the settlement, (2) explore and test appropriate materials with which to model it, and (3) make the model.

➢ CONTEXT:

From the beginning of the term, sixth-graders should be aware that they will be designing an extraterrestrial settlement. Here are some things they can think about weeks before the assignment is given: Where will their settlement be located? Mars? the Moon? Or some newly discovered planet? What will be the purpose of their new civilization? Perhaps the settlers are there for mining, scientific research, or to participate in zero-gravity sports. How many people will live there? What will be the name of this settlement?

➢ CONCEPTS:

There are four important concepts that should be introduced at the start of this activity:

1. **Functions of a community**. A community is a place where a group of people lives. As such, it should contain provisions for the needs of those people. The mere existence of a community can provide for psychological needs, such as comfort, love, etc. But the community needs to supply the immediate physical needs of people, the most basic of which (other than air and water—see #4 below) are food, clothing, and shelter. Other important needs that support these include tools and utensils, storage, and recordkeeping. What are our other needs? In order to better provide ourselves with food, clothing, and shelter, we find we need education, communication, and transportation. All of these things are **functions of a community**, and each needs to be considered when planning one—even if it's on some faraway planet.
2. **Common layouts for communities**. A good question to lead this discussion with is "is it better for people to live near factories where they work?" Either response can be logical. Arguing that "yes, of course they should" makes sense because why should people have to travel far to go to work? Then again, do people want to live near factories, which may cause noise, air, or water pollution, traffic congestion, and the like? Common community layouts include:

   - a centralized commerce or industry district surrounded by living areas (for example, a large manufacturer which employs 50% of a community's workforce);
   - an important institution (school, courthouse, park, etc.) surrounded by living areas, with industry on the outskirts and commercial areas throughout;

- a major industry located at one end of the community and based on an existing resource (lake, mines, etc.), and commerce and residences necessarily emanating in one direction (e.g., a community with a winter-tourism-based economy at the foot of a mountain);
- a major thoroughfare (river, railroad, or highway) dividing a town or a major intersection (two or more highways or railroad lines) defining the "hub" of the community.

3. **Basics of community design**. This discussion is best held just as students are beginning to brainstorm and produce rough sketches of their extraterrestrial settlements. Barring very specialized communities (e.g., holy sites, military bases, scientific-research outposts, or remote natural resource worksites), communities are *zoned* into three general types of areas: *residential*, areas where people live and which generally do not contain businesses; *industrial*, where only businesses are allowed; and *commercial*, designed for retail businesses like stores and malls, as well as living spaces for people. Churches, libraries, schools, and governmental buildings may be found in residential or commercial zones, depending on their purposes. Of course, there are special zones, hybrid zones and even unzoned areas, but sixth-graders should be aware of the three basic types. Those who have used the computer game *SimCity* should be quite familiar with these concepts. Once they are introduced to the idea of zoning, students can be expected to display it in their designs.

4. **Extraterrestrial environments**. It's important to remember that extraterrestrial environments—at least as far as we're aware—do not contain sufficient oxygen or water to sustain human life. Thus any plan for a community on a planet other than earth will need to account for these two requirements. The most popular ideas are building a dome on the planet's surface (the *biosphere* notion); building modular structures on the surface with causeways between them (which might be called a "campus" design); constructing solely or almost solely under the surface of the planet; or some combination of above-ground and underground construction. If the planet is very close to or very far from the sun, the surface might be dangerously hot or cold, so any community would have to be built below the surface. Other planets might have habitable surfaces that are too dense to efficiently excavate; on these planets only above-ground settlements would be possible. However you address this issue, air and water will need to be supplied to this community.

➢ **CHRONOLOGY:**

It may be best to spend the first few days on introducing the above concepts and having the students begin to generate design ideas. By the third day, students should begin to lay out their communities. Students should work in groups of two to four for this activity, and the teacher may choose to assign specific students to groups or have students self-select into teams. However groups are determined, they should be set up on the first day of the activity so that students can begin generating ideas right away. The activity phase of this project can be broken into two parts:

PART I (5-6 days): The design-and-model phase. Students begin with sketches, choose the best one, render technical drawings, and begin to construct a model. However, no glue or other adhesives or fasteners are used yet, so that feedback from the teacher and other students can be digested before the final design is "set in stone." As Part I is winding down, students should have a chance to informally present their ideas to others and listen to other groups describe their projects.

PART II (4-5 days): After any redesigning, the groups can make permanent models. They will also begin to prepare for the presentations they will give the class. Each group should organize and give a brief presentation to the class which explains how their settlement functions, identifies the major elements of the community, and describes how the settlement will be maintained. One twist to liven up the activity is to have the presenters "pitch" their settlement to the class, who can act as potential community dwellers. The class can vote on where they'd most like to live.

➢ **CONTINUATION:**

The final unit of the grade six curriculum concerns engineering design, so a good segue into Unit 6-3 may be to have students produce schematics of their cities using rulers, pencils, templates, and compasses on graph paper. potential follow-up activities in writing may include telling the story of how people will travel to this faraway planet and actually construct the settlement; drafting a "city charter" for the community, or, from the point of view of a settler, writing a series of letters "back home" to Earth.

In this unit, students will design, assemble, and troubleshoot electronic circuits. After learning the functions and interrelations of basic components, they will be challenged to design and build a working intercom system.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Draft basic blueprint plans, Building and inspecting, Collection of feedback data, Expansion and redevelopment based on feedback, Report findings

➢ **TECH LAB BASICS:**

Introduction to the concept of electronics engineering design, Practice working in groups

➢ **SCHEDULE:**

DAY 46—**Instruction**: basics of electricity; electronic circuitry
ACTIVITY➔ personal experiences with electronics and electricity
DAY 47—**ACTIVITY**➔ layout and analysis of simple electronic circuits *<6.3.A. Elements of electronics-engineering design>*
DAY 48—**Instruction**: challenges in approaching problems creatively. *<6.3.B. Brainstorming, creativity, and creativity>*
ACTIVITY➔ door security system. Students design and build a functioning alarm/buzzer system.
DAY 49, 50, 51—**ACTIVITY**➔ door security system, continued. Students continue working on their security systems, testing and troubleshooting them.
DAY 52—**Instruction**: using schematics to plan and lay out electronic circuits.
ACTIVITY➔ laying out and drawing schematics *<6.3.C. Basic schematic sketching >*
DAY 53, 54, 55—**ACTIVITY**➔ students apply their new skills in circuit design and schematic sketching to design, build, and troubleshoot a functioning intercom system *<6.3.D. Production layout >*

ACTIVITY

➢ **CONTEXT:**

In this activity, students design, build, and test a functioning alarm/buzzer system.

Background information: basics of electricity; electronic circuitry; brainstorming and troubleshooting.
Safety needs: all students will need safety glasses and instruction on the safe use of an X-Acto knife and electronic components.

➢ **CHRONOLOGY:**

STEP 1: Explain the challenge to the students: they are to design and build an electrical circuit serving as an alarm or buzzer that will inform them when someone is entering a room.
STEP 2: Demonstrate the construction of a simple circuit that allows the user to turn on a light by opening or closing a switch.
STEP 3: Have each student or group replicate the circuit. Then have them make a circuit that turns on a buzzer when a switch is closed.
STEP 4: Identify and demonstrate the on-off, push-to-make, and toggle switches. Instruct the students to determine, by experimentation, which is the most appropriate for a door-buzzer switch.
STEP 5: Demonstrate the steps for making a personalized membrane switch for a door-buzzer system:
* Sketch out several designs for the switch cover. Identify your best sketch and have it approved.
* Make a full-sized drawing of the cover on card stock and cut it out.
(The cover should be about the size of a light-switch panel.)
* Cut out a piece of card stock the same size for the back of the switch.
* Cut out a piece of plastic grid material the same size for the center of the switch.
* Decide what part of the cover will be depressed to close the switch
* Carefully trace it on to the plastic grid material.

* Cut hole out of the plastic grid using the X-Acto knife and safety rule.
* Use the plastic grid to trace the hole on to the cover of the switch (not the side with the artwork). (Do not cut anything out of the cover!)
* Use the plastic grid to trace the hole on to the back of the switch; do not cut.
* Stick two pieces of copper tape vertically across the "window" you've drawn on the **back**. (Both pieces must go across the "window" but must not touch.)
* Solder a piece of wire to each of these lengths of tape.
* Test the switch by placing it in a breadboard circuit and using a piece of wire to close it.
* Make any necessary adjustments before continuing.
* Stick two pieces of copper tape horizontally across the "window" you've drawn on the **cover**.
* Assemble the switch as follows:
    * Place the **back of the switch** (cardstock) on the work table, **tape-side up**.
    * Place the **center of the switch** (plastic grid) on the back.
    * Make sure that the plastic blocks neither piece of tape on the back.
    * Adhere the center to the back.
    * Place the **cover of the switch** on the center, **tape-side down**.
    * Test the switch before adhering the cover to the center.

STEP 6: Have the students, in teams, apply their knowledge of membrane switches and breadboard circuits to create a circuit which will turn on a lamp when door is closed. You may assign groups to cabinet doors, drawers, windows, etc.

STEP 7: Assign the students to design a dual buzzer/door alarm system which can function in two ways:
* It turns on a light when someone presses a button outside the room; and
* It sounds a buzzer when the door is opened.

➢ **CONTINUATION:**

If additional time is available, students may be given the challenge to design and build a circuit which allows them to transmit sound from one location to another. Additional materials for this project will include microphones and speakers. Because it is very likely that students will design a "closed circuit" communications system using a small battery, they will need to include a switch at the transmission site in order not to put constant strain on the battery.

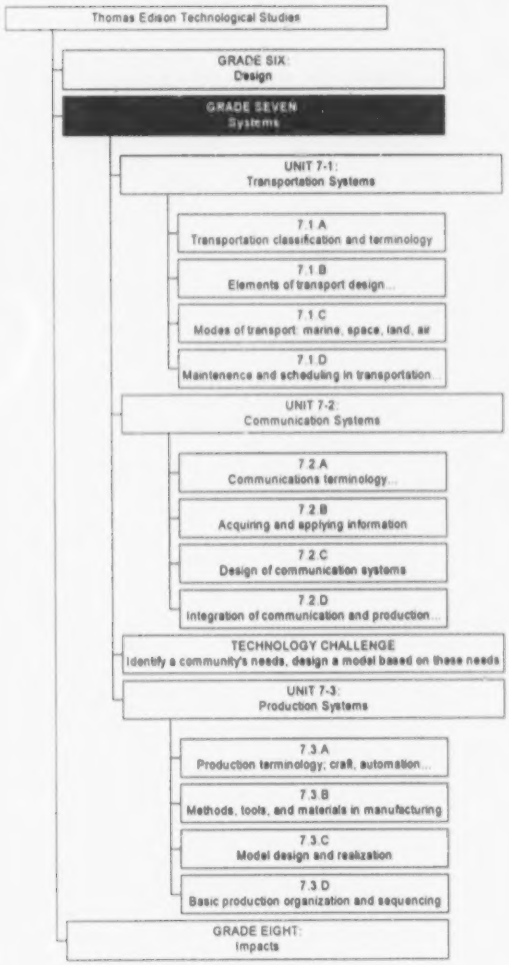
A further challenge would be to build a two-way intercom system. The simplest way to do this is to design two separate circuits that may be used simultaneously. This will allow for "full duplex" communication: in other words, both parties can listen and speak at the same time. Allowing for simultaneous, two-way transmission and receipt in an integrated system that uses battery power may prove to be very challenging. Students may want to experiment with "voice activated" microphones from Radio Shack or taken from junked tape recorders. In order for this to be practical, students would have to ensure that background noise was not sufficient to trip the closing of the circuit, or the battery will not last long!

EXTENSION IDEAS FOR UNIT 6-3

FOG CATCHER...here is an activity that has been taken in a lot of directions. It can be a one-day problem-solving challenge or a multi-week research and design project. In a nutshell, students are challenged to **design and construct a "fog catcher"**—a contraption that captures fog, allows it to condense, and collects the resultant water. The fog can be simulated by dry ice or boiling water [WHETHER YOU USE BOILING WATER OR DRY ICE, BE VERY CAREFUL IN HANDLING THE CHEMICAL BEING SUBSTITUTD FOR FOG]. Materials which work well are nylon netting (scraps may be available from a local fabric store), garbage bags, empty glass or plastic bottles, soda straws, and plastic tubing. If time permits, have the students research the real fog catchers in use in Chile.

ALTERNATE ENERGY IN HOME DESIGN...in this two-day activity, students are challenged to put a new twist on an old idea: they will **design a home which employs some alternate energy source**. The home should probably be small (perhaps 3 bedrooms and 1½ bath, or whatever the instructor chooses), and the energy source should be renewable (solar energy will probably be the most popular choice, but water power, wind power, or any other source should work as well). The first day should include an introduction to the activity, student planning, and the generation of a rough sketch by each student or group. On the second day students should develop final drawings and a brief written explanation of how their design employs alternate energy sources...

Grade Seven
Technological Studies Curriculum Structure



Science Unifier: Life sciences and chemistry
Technology Unifier: Systems
Primary Theoretical Level: THEORY AND PRACTICE
Primary Activity Level: THEORY AND PRACTICE
Activity types: Grade seven activities represent a mix of constructional activity and content learning. The grade seven technology challenge is a hands-on activity requiring the application of knowledge and experiences gained in grades six and seven.
Technology Challenge: Develop an integrated-systems model of a modern community.

The first year this course is taught, grade seven students may not have had Technological Studies in grade six. Their first-week introduction should be the same as that for grade six students. The first-week-introduction on the next page is for grade seven students who are in their second year of technological studies.

Vocabulary

alternating current
amplifier
architect
communication system
component
conductor
construction
current
custom-made
electric motor
engine
engineer
estimator
graphic communication
interchangeable
internal combustion engine
isometric
just-in-time manufacturing
kinetic energy
manufacturing
marine
mass production
noise
potential energy
production
propeller
prototype
receiver
robot
specifications
structure
technical drawing
transistor
transmitter
union
voltage
work

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GRADE SEVEN SCHEDULE

DAY 1—Overview of technological studies; student seating and partner pairings; teacher introduction
DAY 2—Review: technology identification activity
DAY 3—Review: problem-solving identification and constraints
DAY 4—Safety review; classroom and lab procedure review; safety exercise
DAY 5—Systems identification

DAYS 6-20—Unit 7-1 (page B-17).
DAYS 21-30—Unit 7-2 (page B-20).
DAYS 31-45—Grade Seven Challenge (page B-23).
DAYS 46-55—Unit 7-3 (page B-26).

DAY 56, 57, 58—Tech Report: students record their production-line work in a tech report.
DAY 59, 60—Catch-up time, lab restoration, etc.; end of term.

GRADE SEVEN INTERNET RESOURCES

These web sites contain lesson plans or other resources that relate to the content of this unit.

PBS' science and technology site provides background information and teaching tips:
http://www.pbs.org/neighborhoods/science
the PBS TeacherSource page has activities, lesson plans, etc. in science and technology education:
http://www.pbs.org/teachersource/sci_tech.htm
the on-line Hands-On Technology Program offers
http://www.galaxy.net/~k12
this site is focused primarily on science education, but has several useful project plans:
http://www.amasci.com/edu.html
the following web sites are designed for students to explore (with supervision!):

a "hands-on, minds-on" technology and science site from Australia http://www.questacon.edu.au
"Dr. Bob's interesting science stuff" http://www.frontiernet.net/~docbob
the Discovery Science Center http://www.go2dsc.org
"Georgia's science and technology adventure" http://scitrek.org

GRADE SEVEN MATERIALS

The tools and materials needed for units 7-1, 7-2, and 7-3 are listed below. The encircled numbers following each item indicates the unit in which it is used; ① indicates unit 7-1, ② indicates unit 7-2, etc.

Consumables (due to the nature of activity③, supplies will vary):

- ❑ basic consumable shop supplies, such as
  - ❑ nails, screws, and other fasteners ①③
  - ❑ aliphatic glue ①③
  - ❑ scrap wood ①③
  - ❑ rags, newspapers, etc. ①③
- ❑ electric hobby motors (1 per land vehicle per student) ①
- ❑ 2" x 4" pine (about 11" per boat hull per student—count one per foot to allow for kerf) ①
- ❑ assorted electrical components, such as LEDs, 9V battery clips, and switches ①
- ❑ light metal rod (coathangers will work, although thicker material is preferable) ①
- ❑ plastic propellers, wheels, gears, and fittings ①
- ❑ ¼" graph paper ①
- ❑ scrap paper ②
- ❑ scrap cardboard (e.g. from cartons) ②

Consumables, con't

- ❑ posterboard ②
- ❑ construction paper (of various colors) ②
- ❑ glue sticks or rubber cement ②
- ❑ glue (white or aliphatic) ②
- ❑ tape (clear or masking) ②
- ❑ finishing supplies such as paint, stains, etc. ③

Reusable supplies:

- ❑ drill bit assortment ①③
- ❑ sandpaper (at least two grit sizes). ①②③
- ❑ illustration supplies such as magic markers, colored pencils, pastel chalk, etc. ②

Tools and equipment:

- ❑ appropriate, sturdy work surface with vises ①③
- ❑ basic hand tools, such as
  - ❑ saws (backsaw, hack saws, crosscut saws, coping saws) ①③
  - ❑ hammers and mallets ①③
  - ❑ tin snips and other sheet-metal working tools ①③
  - ❑ hand drills (battery-powered) ①③
  - ❑ rules, levels, tape measures ①
  - ❑ files, rasps, etc. ③
- ❑ a selection of files, rasps, and surform tools ①
- ❑ tub or trough (for hull-design testing) ①
- ❑ stationary drill press ①③
- ❑ stationary electric "scroll" (reciprocating) saw; saw blades ①③
- ❑ 45°/90° miter box. ①③
- ❑ tape measure (at least 50' long) ②
- ❑ clipboards and pens ②
- ❑ wood or heavy cardboard work surface ②
- ❑ rules, triangles, compasses, and other drawing aids ②
- ❑ X-Acto knives or scissors ②
- ❑ paper cutter ②
- ❑ hole punch ②
- ❑ stapler & staples ②
- ❑ measuring devices such as rules, levels, tape measures, architect's or engineer's scales, and dividers ③
- ❑ palm sanders ③
- ❑ finishing materials, such as
  - ❑ brushes or other applicators ③ ❑ pans ③ ❑ drop cloths ③
- ❑ calculators ③

Research resources:

- ❑ appropriate schematics technical illustrations of boat hulls ①
- ❑ computers with internet access and drawing software ①②
- ❑ computers with word processing, charting, and CAD software ③
  - ❑ appropriate training materials for specialized software (manuals, tutorials, etc.) ②③
- ❑ printers (accessible from computers); printer supplies (toner, paper, etc.) ①②③
- ❑ print resources (books, magazines, etc.). ①②③
- ❑ school maps (if available) ②

UNIT 7-1: TRANSPORTATION SYSTEMS

In this unit, students will acquire and apply knowledge and skills related to transportation technologies. Specifically, they will design and test working models of a land-transport system (an electric car) and a similar marine system. Students will then compare and contrast the systems in a "tech report" written at the end of the unit.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Identification of transportation needs, Develop and plan isolated transportation routes and systems, Identification of material needs, Produce a technical report

➢ **REVIEW ACTIVITIES FROM GRADE SIX:**

6.1.A. Problem-solving identification
6.1.B. Constraints of problem-solving
6.1.D. Real-life problems

➢ **SCHEDULE:**

DAY 6—**Instruction**: introduction to transportation; kinds of transportation; using transportation words. *<7.1.A. Transportation classification and terminology>*
ACTIVITY➔ identifying transportation systems in the community.
DAY 7—**Discussion**: parts of a transportation system. *<7.1.B. Elements of transport design: propulsion, control, etc.>*
Demonstration: basics of model electric-car construction.
DAY 8, 9, 10—ACTIVITY➔ Part I: "electric car" construction activity.
DAY 11, 12—**Discussion**: Identifying similarities between transportation systems; marine travel (buoyancy, etc.). *<7.1.C. Modes of transport: marine, space, land, air>*
ACTIVITY➔ "electric car" construction, continued.
DAY 13, 14, 15—ACTIVITY➔ Part II: "vessel challenge" activity.
DAY 16, 17, 18—TECH REPORT➔ students prepare a brief tech report detailing the work they completed in designing and constructing the electric car and boat. *<7.1.D. Maintenance and scheduling in transportation systems>*
DAY 19, 20—**Catch-up time**.

ACTIVITY

➢ **CONTEXT:**

In this activity, students design and compare models of land and marine transportation.

Safety needs: all students will need safety glasses and training on electrical safety and in the use of all equipment used. Smocks or lab aprons should be available.
Cleanup needs: dustpans and handbrooms or a hand-held vacuum cleaner for sawdust; water and soap for glue.

➢ **CHRONOLOGY:**

STEP 1: Explain the goals of the activity: students will construct a model of a vehicle intended for land transportation. After learning about marine transportation design, they will then apply the knowledge they gained from the land-transportation project to constructing a vehicle intended for water transportation.
STEP 2: Demonstrate to students the steps involved in making an electric car:
* Sketch out several designs for the body and the mechanics of the vehicle.
* Identify your best idea and present it as a formal drawing for the teacher's approval.
* Construct a bill of materials for the vehicle.
* With your teacher's approval, collect the materials needed for the chassis and carriage system.
* Begin construction by cutting the pieces for the vehicle's chassis. Do not glue it together yet!
* Check the chassis for smoothness and squareness.

* Continue construction with providing for the wheels and axles (the carriage system).
* Assemble the chassis and the carriage system. Again, do not glue the car together yet. (It is vital at this point to make sure that all holes have been drilled properly.)
* With your teacher's approval, collect the materials needed for the electrical system.
* Build and test the motor circuit.
* Identify and make any adjustments to the vehicle needed to install the electrical system.
* Assemble the entire vehicle to make sure everything fits together.
* With your instructor's approval, conduct a temporary assembly of the vehicle.
* Test the vehicle before permanently assembling it.

STEP 3: Provide the students with the following guidelines for the design and construction of a model electric car. the following are suggestions which should ensure the fair distribution of materials:
* It must employ exactly one electric motor of the type provided by the teacher.
* It must use gears, and use them appropriately: no direct-drive systems are allowed.
* It must be designed and assembled in such a way that gears can be changed.
* It must have at least two wheels and no more than four.
* It must travel at least twenty feet without any payload.
* The distances and circumstances of all trial runs should be recorded.
* Complete notes of your planning, construction, and testing must be available to the teacher.
* You must provide and protect your own batteries.
* You may borrow someone else's batteries with their permission.

STEP 4: When most students are finished with their electric cars, demonstrate means of "gearing up" and "gearing down" a vehicle to affect its speed and payload capacity.

STEP 5: Have students modify their electric car design to either increase its speed or its payload capacity. Each student should be able to furnish complete records of all modifications and their results.

STEP 6: Recalling the aerodynamic principles learned in the grade six glider activity, explain the next project: students will explore hydrodynamics by modeling and testing boat hull designs. Later they will build an electrically-powered boat.

STEP 7: Demonstrate the steps that should be taken to make a model boat hull of the displacement and planing types.

STEP 8: Issue these design constraints for the design and construction of a battery-powered boat:
* It must employ exactly one electric motor of the type provided by the teacher.
* Gears are optional, but the boat must be designed to accept them with minor modificaitons.
* It must travel at least twenty feet in a straight line.
* The distances and circumstances of all trial runs should be recorded.
* Complete notes of your planning, construction, and testing must be available to the teacher.
* The same rules about batteries that applied in the electric car project are applicable here.

EXTENSION IDEAS FOR UNIT 7-1

EFFECTS OF TRANSPORTATION ON GLOBAL WARMING...students investigating **transportation technology** will probably wonder about its environmental effects. This may be a good time to introduce the notion of filtering data through a critical lens. Most scientists believe that the earth is undergoing a sustained warming trend, although not all do. Many who agree that global warming is a reality still disagree on its exact causes—and just how bad it is. All of this makes it difficult to identify the effect of modern transportation on the temperature of the earth. In this activity, **students use the library or conduct internet research to estimate what, if any, impact transportation has on global warming**. Only web sites designed for school use should be accessed (unless the teacher specifies otherwise), and students must identify a diversity of opinions in order to complete the assignment...

TRANSPORTATION IN THE COMMUNITY...when they are in grade eight, students will be required to conduct a community survey (in Unit 8-1). Having seventh-graders **design a simple transportation questionnaire, conduct it, and analyze the results** might be a good introduction to this type of research while they are learning about **transportation technology** in Unit 7-1. A questionnaire on mass transit might include questions designed to get at the characteristics a mass-transit system would require to be successful in the community, or how much individuals would consent to having their taxes raised per year to make such a system possible. Or the questionnaire might include questions about carpooling, telecommuting, and bus-riding as a way for individuals to help reduce pollution. Once the results are in, they should be tabulated and charted, and conclusions should be drawn. This activity might be used as a term-long project that is done as time allows...

INTEGRATED, AUTOMATED INDIVIDUAL TRANSPORT...here's a far-out **transportation technology** idea that should inspire thinking and creativity among seventh-graders. Some futurists have speculated that someday people's desire to have their own personal vehicles will win out over the more economical notion of rapid mass transit. There are a surprising number of web sites on the topic of PRT—Personal Rapid Transit. The challenge to students is to **identify considerations in designing an automated highway system** that uses individual vehicles. Could existing byways and vehicles be fitted to work under such a system? What would be the advantages and disadvantages of such a system? Students, perhaps in groups, should provide a brief, clearly-worded written description of how the system would be designed, implemented, and maintained. A technical sketch should accompany the description...

UNIT 7-2: COMMUNICATION SYSTEMS

In this unit, students will explore the communications systems in the world around them—specifically, their school. They will use newly acquired graphic-communications capabilities and build upon grade six drafting skills in constructing a scale model of the school structures and grounds.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Identification of communication needs, Develop and plan isolated communications systems, Identification of material needs, Plan, test, and troubleshoot integrated systems

➢ **REVIEW ACTIVITIES FROM GRADE SIX:**

6.3.A. Elements of design
6.3.B. Brainstorming and creativity
6.3.C. Basic sketching

➢ **SCHEDULE:**

DAY 21—**Instruction**: introduction to communication; using communication words. *<7.2.A. Communications terminology; mass and interpersonal communication>*
ACTIVITY➔ identifying communication systems in the community.

DAY 22, 23— ACTIVITY➔ accessing local network information; finding and applying information on the internet.*<7.2.B. Acquiring and applying information>*
Instruction: types of and differences between communication systems.

DAY 24—**Instruction**: researching and outlining the history of communications and communications technology. *<7.2.C. Design of communication systems>*
ACTIVITY➔ basic digital communications; binary and ASCII communication.

DAY 25, 26, 27— ACTIVITY➔ Part I: collect the data that will be needed to create two- and three-dimensional maps of the school.

DAY 28, 29, 30— ACTIVITY➔ Part II: create a physical model of the school grounds. *<7.2.D. Integration of communication and production systems>*

ACTIVITY

➢ **CONTEXT:**

In this activity, students survey and map the physical plant of the school.

Background information: mass and interpersonal communication; graphic communication; binary/ASCII system; integration of communications and production systems; communications terminology.

Safety needs: all students will need safety glasses and training on using glue, X-Acto knives, and the paper cutter.

➢ **CHRONOLOGY:**

STEP 1: Orient students to the second challenge of grade seven technological studies: they will construct an accurate, three-dimensional map of the school grounds. Since this is a large task, different pieces of it will need to be done by different groups; yet all of the pieces will need to come together in a final project.

STEP 2: Have students use tape measures to survey the grounds of the school. Depending on the availability of supervision, this may take several forms. If supervision is available, different groups of students may be able to work at different places at the same time. Otherwise, the teacher and students will need to canvass the school, area by area. These considerations will dictate group sizes.

STEP 3: Students should begin by identifying perimeters (of the grounds, the building, etc.) and work their way inward. Separate levels of the building will need to be drawn separately. Emphasize accurate measurement!

STEP 4: Collect all data on large pieces of butcher paper. Use an appropriate scale.

STEP 5: Once complete perimeter data is available, assign one group to begin a scale drawing on the computer (you may assign several groups to do this if you wish). They may need to leave class to go "on-site" to check measurements. If this is not possible, they will need to make an error-check list containing discrepancies that volunteer students can investigate before or after school. Eventually, these students will produce complete, accurately scaled floor plans.

STEP 6: A second team of students can begin to cut out materials for uniform model parts such as walls. This group can also begin to assemble a base for the three-dimensional model. Eventually this team will use the computer-generated floor plans to build a high-quality scale model of the school.

STEP 7: A final group should begin creating a two-dimensional display that clearly identifies for visitors each important location at the school. It is important for this display to accurately reflect the three-dimensional model. Eventually, these displays can be placed around the school with "YOU ARE HERE" designations.

➢ **CONTINUATION:**

If additional time is available at the end of this unit, or if several students are available, a group can build weather stations at several places on campus, collect data, and communicate readings via a school "weather map" which can overlay the map made in this unit. Several atmospheric measurement instruments can be made easily from readily available materials. Instructions can be found in several middle-school science texts; at many of the web sites on page B-15, or in several of the texts listed on page C-13.

An **anemometer** measures wind speed. This device can be made from wood and sheet aluminum. Wind speed is measured using the anemometer in conjunction with a stopwatch.

A **barometer**, which measures air pressure and might be useful in identifying changes in weather patterns. It isn't necessary to use mercury to make a barometer, but a long, thin glass tube is helpful (clear plastic tubing can substitute).

Humidity, or moisture in the air, can be measured with a lab-made **hygrometer**. There are many designs for building a simple hygrometer, but all have one thing in common: they require a long human hair, which responds predictably to changes in air moisture content.

Students can also build a **thermometer** to measure air temperature. Having an ordinary thermometer handy during testing can ensure high-quality results.

Finally, wind direction can be measured with a **weather vane** or a **windsock**, both of which are very simple to make, yet if constructed carefully, can be quite accurate.

With these instruments, students can provide accurate indoor and outdoor readings of air pressure, humidity, and temperature, as well as outdoor readings of wind speed and direction. If students record and plot this information over a period of time, they should be able to identify environmental differences in different parts of the building, or at different locations on the school grounds. This relative atmospheric data can be used to add detail to the school map, or can be the basis for a "weather map" of the school.

EXTENSION IDEAS FOR UNIT 7-2

DREAM HOME...this activity can be implemented as a one-period fun project to get students thinking about design constraints, or as an in-depth project lasting a week or more in which students consider these constraints in detail. The challenge is for the students to **plan and design (and, time permitting, build a model of) a home which satisfies two major design criteria**. First, the instructor may choose to impose square-footage requirements or specify a minimum of room types that must be included. Second, it must be a "dream home"—each student's design must include the elements that the student identifies at the onset of the activity. Students start the design process with a series of elements that need to be included and constraints that need to be observed, then set out to integrate the elements in a unified design. Although this is primarily a **communications** activity, it may serve as a good segue into a discussion of production (Unit 7-3) ...

PACKAGING REDUCTION...an exercise in **communications technology**. Product packaging must perform several functions, including to identify, promote, and protect the item inside. But, as the class can be shown,

packaging is sometimes quite wasteful. A balance scale can help identify packaging which weighs more than the product is contains. In this activity, students use available materials to **design and prototype more economical packaging for existing products**. This will involve comparing the environmental effects of different materials, investigating the special protective needs of the product (can it leak or spill?), and exploring ways of reducing waste (can flashy advertising be displayed next to the products in the store, rather than repeated on each package? can instructions be printed on the package rather than on a separate piece of paper inside?)...

SCHOOL SIGNAGE...this may be a good follow-up or enrichment exercise to the Unit 7-2 activity in which students survey and map their school and grounds. In this activity, students **design and implement a signage system that will help visitors find specific locations around the school**. The challenge is to design a system which will "blend in" with the design of the school, yet "stand out" enough to function properly. What locations around the school might visitors seek? What size and format would be most appropriate given existing signs around the school? Students will be exposed to the notion that **communications technology** may not always be "high-tech." If possible, have the students look into the possibility of actually implementing the solution at the school. In future years, other students might analyze the signage and make recommendations as to improvements, substitutions, or alterations...

SCHOOL BROADCASTING STATION...with less than $100 of equipment from Radio Shack, members of the class can **set up a radio station**—maybe even one which broadcasts over the school's PA system. Over a few class periods, students can discover the careful planning required to keep a broadcast show on schedule. Whether planning a five-minute news update from multiple correspondents, or a one-hour segment of music, DJ chatter, and commercials, this **communications activity** can enrich the students' sense of the importance of planning and making a schedule, following a schedule, and making in-progress corrections to stay on schedule...

GRADE SEVEN CHALLENGE

The grade seven challenge is to design and model a community which takes into consideration the transportation, communications, and production needs of that community. Below are some ideas that might aid the teacher in providing a meaningful fifteen-day activity.

➢ **SCHEDULE:**

DAY 31—**Discussion**: identification of community needs; classification of needs (production, communication, transportation).

DAY 32—**Instruction**: using transportation systems as a basis for community planning; using communication systems as a basis for community planning.

ACTIVITY➔ sketching transportation and communication webs for communities.

DAY 33, 34, 35—ACTIVITY➔ Part I: community design [communication and transportation systems].

DAY 36—**Discussion: zoning**; placement of residential, commercial, and industrial structures in a community.

ACTIVITY➔ continue Activity Part I if needed.

DAY 37, 38, 39, 40—ACTIVITY➔ Part II: model construction.

DAY 41—**Demonstration**: how to present your group's plan to the class. ACTIVITY➔ Part II, continued.

DAY 42, 43—**Student presentations**.

DAY 44, 45—**Catch-up time**.

ACTIVITY

➢ **CONNECTIONS:**

The other units in the grade seven curriculum are concerned with the technologies of transportation, communication, and production. If the timeline on page A-8 is followed exactly, the grade seven challenge follows Unit 7-1, which deals with transportation, and Unit 7-2, communication. These are the two most important systems to consider in a seventh-grade treatment of urban planning. Thus, students should be very ready for this challenge, having just completed an investigation of how people communicate and move themselves and their materials.

In addition, it should be noted that this activity bears particular resemblance to the grade six challenge, in which they designed and modeled an extraterrestrial community. Although during that grade six activity they were probably not thinking specifically of technological systems, now, a year later, they have had the experience of designing a community.

One major difference between this project and the grade six challenge should be the introduction of *scale*. Students should be instructed in the use of the architect's or engineer's scale and a reasonable adherence to the principles of scale modeling should be expected. It is important to point out to the students that they will not be able to figure square footage, acreage, or square mileage without proper application of scale.

➢ **CONTEXT:**

Here are several ideas for constraints that the teacher may put on the design of the community in this project. Constraints should be chosen to add challenge and fun. Perhaps students should choose a specific number of constraints from a list such as this:

- The community must run exclusively on alternate energy sources like water, wind, and solar power.
- The community must be designed so that no private vehicles are allowed except for the outskirts. Only mass-transit vehicles will be allowed in town. Perhaps the in the central square mile or two, only biking and walking would be allowed. Another variation is to replace all sidewalks and road with escalators and conveyance systems.
- The community will be totally "wired." Some sort of materials-transportation system will be in place so that people can order groceries, household supplies, and library books on-line and have an automated system ship them.
- The community is from a specific historical era.
- The community must have a specific acreage of parkland, farmland, or undeveloped land.

Another twist that might make the activity more exciting would be to pair groups and expect the two groups in each pair to design compatible communities; that is, communities whose thoroughfares connect, which are built

on the same landscape, and which do not unnecessarily duplicate services. One group in a pair might provide the library and hospital while the other provides the schools and sports fields. Whatever the groups decide, they must use the same scale in constructing their models. For a real challenge, give each group the same-sized, piece of cardboard or plywood and instruct the class that all of the communities must connect together!

➢ **CONCEPTS:**

There are three important concepts that should be introduced at the start of this activity:

1. **Identification of community needs**. This discussion can begin with a laundry list, provided by the students, of the needs of human beings: air, water, food, clothing, and shelter will come first, and based on Units 7-1 and 7-2, students should suggest some basic forms of transportation and communication as well. What else? Tools and machines? Education? News?

2. **Classification of community needs**. The next step, once an exhaustive list is constructed, is to begin to classify these needs. Education and news, for example, are forms of communication, as are telephone, television, and internet service and entertainment. Many physical needs can be classified as transportation, communication, or production. For ease of understanding, *production* can be broken down into *manufacturing* and *construction*. Here are some other ideas with which to get started:

Production		Transportation	Communication
Construction, utilities	Manufacturing		
• Houses, homes • Factories, farms, shops, stores, malls, government and office buildings, schools, churches, libraries, etc. • Stadiums, arenas, sports fields, parking garages, etc. • Power for heating, cooling, etc. • Natural gas service • Water supply • Storage	• Food, clothing production • Tools, machines, agricultural equipment, supplies • Building materials • Medical supplies • Transportation and communications equipment (cars, computers, etc.)	• Bikes, skateboards, skates • Cars and other personal vehicles • Buses, trains, planes, and other mass transit • Trucks, trailers, cargo ships, and other shipping vehicles • Postal system • Roads, highways, traffic and other signage	•Telephone service: land and wireless •Cable, satellite, internet connections •Media: broadcast stations (radio, TV); newspapers •Recordkeeping systems •Security systems

Many items will fall into multiple categories; an airplane is manufactured, and then used for transportation; if used for skywriting it is also an application of communication.

3. **Using transportation systems or communication systems as a basis for community planning**. As long as a community is being planned from scratch, it can be built upon an integrated network of transportation and/or communication services. For example, before building and road construction takes place, underground transportation and communication systems could be built. The locations of above-ground terminals (for both transportation and communication) would be determined before residential, commercial, and industrial zones would be identified. Even if a more traditional community is planned, the system of roads, railroads, and utility lines should be considered before buildings are placed.

➢ **CONSUMABLES:**

The supplies listed on pages B-18-19 should be sufficient for this project. The teacher may choose to have students fill out a materials specification form before procuring materials. A related strategy is to give students a budget and charge groups on a per-piece basis for supplies.

➢ **CHRONOLOGY:**

The activity phase of this project can be broken into three parts:

PART I (approx. 4 days): Students plan their communities, specifically detailing communications, transportation, and production systems.

PART II (approx. 4 days): In this part of the activity, students begin constructing models of their communities, clearly depicting each system.

STUDENT PRESENTATIONS (approximately 2 days).

➢ **CONTINUATION:**

There are several good math connections to this project that might make suitable follow-up exercises. Here are some ideas:

- Produce two dimensioned drawings of one block of your community: one using English units and one in metric/SI.
- Identify groups of design elements (not just individual objects) in your community or from a map presented by the instructor which suggest basic geometric shapes. Are concentric circles or ellipses evident? Why? Are the angles of intersection of roads important? Why?
- Calculate the total square footage of a building in your plan; figure out how many square feet of land the building sits on, then convert this to acres; express the total residential area of your community in square miles and in acres. Describe how you arrived at the answer if all of the residential areas are not rectangular.

A lot of additional technology learning can come from this exercise if there's time. Students can analyze likely traffic patterns, identify what the most common occupations of people in their community, look at how waste management, mail delivery, and snow removal would be accomplishes, or hypothesize how their community might change over the next 10, 25, or 100 years.

The final unit of the grade seven curriculum concerns production technology, so bridging from this project into Unit 7-3 should be straightforward. Especially if production technology is divided for discussion purposes into manufacturing and construction, the connections should be obvious to students. Once transportation and communication systems are designed, construction can be planned. If the class uses standard units (such as wood or styrofoam blocks) for architectural elements, the teacher might consider having the class mass-produce these to certain specifications as a means of introducing concepts of production.

UNIT 7-3: PRODUCTION SYSTEMS

In this unit, students will design a manufacturing production line to mass-produce a product to specifications. This will require coordination and teamwork, along with a working knowledge of the major components of a simple manufacturing system.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Identification of material needs, Plan, test, and troubleshoot integrated systems, Model a complete system, Produce a technical report.

➢ **REVIEW ACTIVITIES FROM GRADE SIX:**

6.2.A., 6.2.B., 6.2.C., 6.2.D. Materials and Processes
6.3.D. Production layout

➢ **SCHEDULE:**

DAY 46—**Instruction**: introduction to manufacturing and construction; using production words. *<7.3.A. Production terminology; mass production vs. custom-making>* ACTIVITY➔ Identifying construction and manufacturing activities in the community; simple *assembly-line* activity.

DAY 47— ACTIVITY➔ "commanding the robot" activity; manufacturing materials comparison. *<7.3.B. Methods, tools, materials in manufacturing>* ACTIVITY➔ Planning a simple process flow.

DAY 48—**Instruction**: mass production and replication; purpose and methods of modeling.
Demonstration: construction of jigs and fixtures for manufacturing; troubleshooting a process. *<7.3.C. Model design and realization>*

DAY 49— **Demonstration**: orientation to production-line activity. ACTIVITY➔ Basic CAD (computer-aided-design).

DAY 50, 51, 52— ACTIVITY➔ Part I: processing, assembly, and quality control. *<7.3.D. Basic production organization and sequencing>*

DAY 53, 54, 55— ACTIVITY➔ Part II: planning, optimizing, testing, and running the production line.

ACTIVITY

➢ **CONTEXT:**

In this activity, students plan and implement a manufacturing line to mass-produce a product.

Background information: line assembly vs. custom production; production planning and layout; manufacturing methods; organization and sequencing in manufacturing; manufacturing/production terminology.

Safety needs: all students will need safety glasses and focused training any equipment they have not used before. Smocks or lab aprons should be available throughout this activity. If special finishes are used, rubber gloves should also be available.

Cleanup needs: dustpans and handbrooms or a hand-held vacuum cleaner for sawdust. If special adhesives or finishes are used, certain solvents may be needed as well.

➢ **CHRONOLOGY:**

STEP 1: Orient the students to the activity: they will analyze a product to be mass-produced, plan and implement a production line, and mass-produce the product.
STEP 2: Break the students up into groups of three or four.
STEP 3: Distribute a mock-up of the product to be produced to each group and instruct them outline the steps necessary to produce the product.
STEP 4: Instruct the students in the procedure for formulating a production line:
* The item to be produced is identified.
* The physical specifications of the product are identified and agreed upon.
* The steps necessary to make the product are outlined.
* These tasks are sequenced, and the sequence is optimized.
* Quality-control standards are identified and agreed upon.

* Custom jigs and fixtures are built and tested.
* The line is assembled, including all personnel, raw materials, equipment, and custom tools.
* The production line is primed and tested, and necessary corrections are identified and made.
* Products are produced; quality-control personnel fine-tune the operation while it is in process.

STEP 5: Divide the students into three teams: Processing, Assembly, and Quality control. The processing and assembly groups should each account for about 40% of the class. If possible, try to keep the original small groups intact. Instruct these teams as to their duties:

* Processing— this group is charged with building all appropriate jigs and fixtures needed to transform the raw materials provided into the rough parts needed for the product. This team will need to identify a sequence of its operations and a layout of all equipment needed to undertake its task of providing the Assembly group with quality rough parts that can be made into the final product. This team has the authority to reject any raw materials approved by the Quality Control team that do not meet specifications, and they may build devices to identify substandard raw materials.
* Assembly—it is the responsibility of this group to identify how the rough parts it will receive will be made into the final product. This group is concerned with all fine smoothing and cutting operations; with assembly; and with finishing. The Assembly team must identify and create all jigs and fixtures necessary to performing its function of delivering a quality finished product. It will need to identify a sequence of its operations and a layout of all equipment it will need. This team has the authority to reject any parts made by the Processing team that do not meet specifications, and they may build devices to identify substandard rough parts.
* Quality Control—this group is responsible for assuring that the product meets all standards and specifications both during and after production. This team is also charged with checking all raw materials to ensure quality, and with identifying and correcting any technical problems that may arise between the Processing and Assembly teams.

STEP 6: After ensuring that each team understands its duties and is aware of the roles of the other teams, assign each the necessary space and equipment to begin its function in the production process. This will take several class periods. During this time, teams should:
* At the beginning of class, send a representative to report to the instructor its plans for the period;
* Keep a complete account of the group's work for that period; and
* Designate a representative to report to the class at the end of each period.

STEP 7: As the teams are completing their work in setting up the production line, shift members of nearly-finished groups to those teams which will need additional help.

STEP 8: Instruct the groups to try a "dry run" of the production line. Based on feedback from the group, identify any problems that need to be fixed before the line can be optimally functional.

STEP 9: Have the students use the production line to produce the product.

STEP 10: Assign students to return to their original small groups. Students should produce two documents for each of the following manufacturing functions—processing, assembly, and quality control:
* A series of directions instructing others on how to make the product; and
* A brief report of recommendations on how to improve the efficiency of the process.

EXTENSION IDEAS FOR UNIT 7-3

REVERSE ENGINEERING...a **production technology activity** that may take several forms. The general idea is to have **students analyze a small product by taking it apart**. Depending on the amount of time available, the next step may be to design a production flowchart and plan of procedure for manufacturing the part. Alternately, a student may affix the parts onto a display board and label them, identifying the likely procedure for assembling the item. Items suitable for this project are nonfunctioning or unwanted, and should be neither too complex nor too simple; for example, an old television set would probably be too much for this activity. [NOTE: NEVER HAVE STUDENTS OPEN THE HOUSING OF A TELEVISION OR ANY OTHER PRODUCT WITH A CATHODE RAY TUBE (SUCH AS A COMPUTER MONITOR, OSCILLOSCOPE, ETC.) WHICH HAS NOT BEEN INACTIVE AND UNPLUGGED FOR AT LEAST 24 HOURS.] A floppy disk is probably too simple. Some examples of products that might be appropriate include any type of tape cassette (VHS, 8-track, standard audio), a TV/VCR remote control, a portable AM radio, a laser-printer or copier toner cartridge (make sure it is really empty and cannot be refilled), or an electric pencil sharpener...

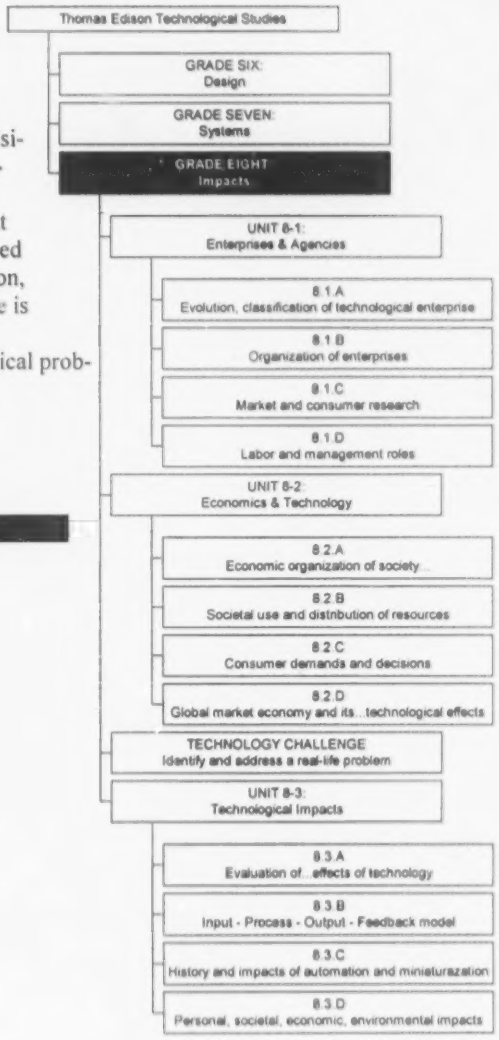
TRANSPORTABLE KITCHEN...in this exercise, **students design a totally enclosed, portable kitchen** which can be easily moved between construction sites to provide efficient, rapid hot meal service to at least 100 workers. Some things to consider: how much room does it take to prepare food for 100 hungry construction

workers? How much time does a construction worker get for lunch anyway? (Do they have time to wait in a long line?) How is the food stored and prepared? Can a tour bus or school bus be retrofitted for this purpose? How can grocery items be loaded on to the transportable kitchen *en masse*? Can the meals be distributed quickly, as they are prepared? And how much energy will all of this require? How will the energy be provided? How much will this cost, how many people will be employed, and what will their jobs be? Time permitting, groups of students might also construct models of selected designs. Although this is primarily a **production activity**, it is concerned with transportation technology as well...

URBAN CONSTRUCTION...architects do more than just draw houses and watch them get built. Often they must promote their designs to developers or other groups that might help make their ideas a reality. In this **production activity**, groups of students are given the requirements for an apartment complex. The number and variety of units, types of services and utilities, requirements for storage and parking, etc. should all be considered. Students are then challenged to **design a solution within the constraints and prepare a brief portfolio illustrating and promoting their design**. If possible, a panel of two or three adults from around the school could help evaluate the designs and presentations...

Technological Studies: Grade Eight

Science Unifier: Integrated study of science
Technology Unifier: Impacts
Primary Theoretical Level: PRACTICE
Primary Activity Level: THEORY
Activity types: Many grade eight activities focus on the acquisition of new knowledge and the integration of this knowledge with prior learning. Some activities are constructional, and many are related to research and development using communications resources such as student-generated publications and information from the internet. In addition, two field trips are recommended. The year-end challenge is entirely activity-based.
Technology Challenge: Identify and address a real technological problem.



Vocabulary words:

acid rain
architect
business plan
cash flow analysis
commission
confluence
contract
coordination
engineer
environment
EPA
ergonomics
fusion
futuring
general contractor
impact
intelligent buildings
magnetic levitation
OSHA
overruns
personal rapid transit
pollution
subcontractor
venture capital
zoning

The first year this course is taught, grade eight students may not have had experienced technology education in grades six and seven. Their first-week introduction should be planned so that they receive all necessary safety instruction. The first-week-introduction on page B-30 is for grade eight students who are in their third year of technological studies.

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GRADE EIGHT SCHEDULE

DAY 1—Welcome-back activity; student seating and partner assignments; teacher introduction
DAY 2—Orientation to grade eight technological challenge activity; pre-planning
DAY 3—Review: classroom and lab procedures; safety-review exercise
DAY 4, 5—Team/group challenge: researching the history of a technology

DAYS 6-20—Unit 8-1 (page B-31).
DAYS 21-30—Unit 8-2 (page B-36).
DAYS 31-45—Grade Eight Challenge (page B-39).
DAYS 46-55—Unit 8-3 (page B-42).

DAY 56, 57, 58—If time permits, students should report on the whole of their technological studies experience at Thomas Edison Middle School.
DAY 59, 60—Catch-up time, lab restoration, etc.; end of term.

GRADE EIGHT INTERNET RESOURCES

These sites contain lesson plans and resources relating to the content of Units 8-1, 8-2, and 8-3.

the South Central Regional Technology in Education Consortium has numerous integrated lesson ideas:
http://www.scrtec.org/
the National Park Service has lesson plans for acid rain activities at this address:
http://www2.nature.nps.gov/ard/lessons.html
the Alliance to Save Energy has a number of teacher resources available on its home page:
http://www.ase.org/educators
about a dozen ecology-related activities are available at
http://www.ceismc.gatech.edu/busyt/eco.html#le
sixty middle-school science lesson plans, including several which deal with technology or the environment, are available at http://ofcn.org/cyber.serv/academy/ace/sci/inter.html
this site tends to focus on military history, but has a lot of information about historical homes and transportation:
http://www.thehistorynet.com/THNarchives/HomesHeritage/
http://www.thehistorynet.com/THNarchives/HistoricTravel/
the Social Sciences Educational Consortium has integrated lesson plans focused on history and current events:
http://www2.nature.nps.gov/ard/lessons.html
the Academy Social Studies Curriculum Exchange has dozens of middle-school ideas:
http://ofcn.org/cyber.serv/academy/ace/soc/inter.html

GRADE EIGHT DESIGN AND DOCUMENTATION MATERIALS

Grade eight students should have all of the tools, equipment, and supplies identified for grades six (listed on pages B-2 and B-3) and seven (pages B-15 and B-16). In addition, students will need as large a variety as possible of graphic communication and illustration materials for units 8-1, 8-2, and 8-3. While the exact materials will vary depending on availability, the following is a list of examples of appropriate supplies for these activities.

Consumables:

- ❑ ¼" graph paper
- ❑ scrap paper
- ❑ scrap cardboard (e.g. from cartons)
- ❑ large sheets of butcher paper
- ❑ posterboard
- ❑ construction paper (of various colors)
- ❑ glue sticks or rubber cement
- ❑ tape (clear or masking)
- ❑ illustration supplies such as magic markers, colored pencils, pastel chalk, etc.

Tools and equipment:

- ❑ all materials-processing equipment listed on pages B-3 and B-16
- ❑ clipboards and pens
- ❑ rules, triangles, compasses, and other drawing aids
- ❑ X-Acto knives or scissors
- ❑ paper cutter
- ❑ hole punch
- ❑ stapler & staples
- ❑ measuring devices such as rules, levels, tape measures, and dividers
- ❑ calculators

Research resources:

- ❑ computers with internet access and drawing software
- ❑ appropriate training materials for specialized software (manuals, tutorials, etc.)
- ❑ printers (accessible from computers); printer supplies (toner, paper, etc.)
- ❑ print resources (books, magazines, etc.).

UNIT 8-1: ENTERPRISES AND AGENCIES

In this unit, students will take the first step toward completing their grade eight technology challenge. They will begin to investigate the impact local technological enterprises and systems have on people, the community, and the environment. They will use market research techniques along with other studies to identify technological systems in the community that may be worthy of investigation. If time permits, they will participate in a field trip that will help them understand the roles different individuals play in a technological enterprise.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Problem identification, Investigation and research, Documentation of a technological problem, Development of a final report

➢ **REVIEW ACTIVITIES FROM GRADES SIX AND SEVEN:**

6.1.C. Applied research
6.1.D. Real-life problems and solutions
6.3.C. Basic schematic sketching
7.1.A, 7.2.A, 7.3.A. Technological classification and terminology

➢ **SCHEDULE:**

DAY 6—**Instruction**: identification of technological enterprises and other organized endeavors. Define and identify examples of technology in the community. **ACTIVITY➔** identifying technological impacts in the surrounding community via newspapers and other media.

DAY 7— **Discussion.** (preparation for field trip): personal experiences in the division of labor; graphical presentation of labor-management relationships; theories of specialization and supervision.

DAY 8—**ACTIVITY➔** Field Trip: on-site observation of labor division. *<8.1.D. Labor and management roles>*

DAY 9—**Instruction**: managing a technological endeavor. Classifying technological systems and subsystems in enterprise. Designing a process flowchart or diagram. *<8.1.B. Organization of enterprises>*
ACTIVITY➔ in groups, students map out the organization of four to eight local technological enterprises, any of which may become the focus of their major grade eight project.

DAY 10, 11, 12—**Instruction**: conducting consumer and market research; the application of graphs, use of summary statistics. *<8.1.C. Market and customer research>*
ACTIVITY➔ collect and analyze data on the impact these technological endeavors have on individuals and the community.

DAY 13—**ACTIVITY➔** wind down and wrap up data collection; illustrate findings using appropriate charts, graphs, and written reports.

DAY 14—**ACTIVITY➔** finish charting/graphing. **ACTIVITY➔** narrow topic list down to three discrete technological problems that the class could plausibly research.

DAY 15, 16, 17—**Instruction**: developing and presenting a short oral argument. **TECH REPORT➔** each of the six groups begins to plan an oral report that they will present to a panel of adults.

DAY 18, 19— **Student presentations**.

DAY 20—**Catch-up time**.

ACTIVITY

➢ **CONTEXT:**

Students will be beginning a new school year or term. This will be their last year of technological studies at Thomas Edison, and their last year before high school. Accordingly, they will be challenged at a higher level this year and will be expected to respond with a greater maturity and astuteness than their younger schoolmates. This year in technological studies, they will begin to take a more critical view of technology, looking not only at its positive aspects, but its negative impacts as well. Students will begin this term by taking the first major step toward the most significant project they will undertake in middle-school technology studies—the Grade Eight Challenge.

➢ **CONCEPTS:**

There are three important concepts that should be introduced during this activity:

1. **Technological enterprises**. Students who have had technological studies in grade six should be well-versed in defining and explaining *technology*—essentially, technology is what happens when people make physical changes to their natural environment. An *enterprise* can be seen as any organized effort made by people for a specific purpose. For example, schooling ought to be the *enterprise* of eighth-graders. Usually, a *technological enterprise* is operated by a group of people; involves multiple technological systems (including transportation, production, and communication); and has *economic* implications, meaning that the enterprise is designed to make money for its owners, has employees, or both. Have students brainstorm examples of technological enterprises. Here are some major categories:

    1. **Businesses that sell products**; i.e., *retail* enterprises. All stores, malls, auto dealerships, real estate companies, bakeries, supermarkets, etc. are examples..
    2. **Businesses that perform services for pay**: movie theatres, utility companies, repair shops, sports arenas, exterminators, junk yards, telephone service providers, etc. This also includes companies that sell advertising: broadcast television stations, radio stations and billboard companies.
    3. **Businesses that sell products and also perform services**, like restaurants, hairdressers, print shops, and many others.
    4. **Business that makes products or harvests raw materials that are sold to other companies**: factories, farms, mines, construction companies, etc.; these are often *wholesalers*.
    5. **All government agencies** are enterprises.
    6. **Most nonprofit** organizations, such as many schools, libraries, fire companies, and hospitals. Businesses which perform these same tasks or similar ones for profit (see #2) are also enterprises.
    7. **Most organized groups, clubs, and teams** qualify as well.

    There are many other examples. Perhaps it would be instructive to provide non-examples of enterprises. Pursuits that are not organized, like talking to a friend on the phone or going shopping at the mall are probably not enterprises. Endeavors that are temporary are also probably non-examples; for instance, a pick-up basketball team would not qualify either. Finally, anything without a meaningful purpose cannot be much of an enterprise. Reading cartoons on the internet is not an enterprise.

2. **Division of labor**. Most enterprises are able to operate because of a group of people work, or *labor*, together. Whenever multiple tasks are to be done by multiple people, the work must be divided; thus the term *division of labor*. Consider a baseball team: the nine fielders divide the labor of defense. In an orchestra or choir, the musicians who play different instruments, or who sing different parts, divide the labor of executing a performance. In order to present a baseball game or concert to thousands of people, a lot more labor has to happen: there are lights, groundskeeping, food concessions, audio and video systems, and many other systems to consider. Of course, for all of this to work, the labor must be divided among a group of people.

    There is more to division of labor than different people doing different jobs. Someone has to make sure everyone is working together, and ensuring this can often be a full-time job. That's why orchestra conductors usually don't perform during concerts and baseball coaches usually don't take a turn at bat. Here's a good debate for eighth-graders: can someone be a truly great baseball manager but a very poor player? Must an orchestral conductor be an accomplished musician? The people whose jobs it is to make sure all these people are working together are often called *managers*. Because division of labor necessitates management, and because managers are people in charge of other people, there is often resentment because workers don't always get along with their bosses.

    Of course, being the boss isn't necessarily better! There are several reasons for this, some of which might be immediately identified by members of the class. Below is a matrix with some of the pros and cons of management. Perhaps it could be drawn on the board with its contents left blank. Students could help fill in the details in a brainstorming session.

	labor	management
pros	• pride in doing good, hands-on work • less worries • clearly defined role • may be eligible for collective action	• more pay • more prestige • better working conditions • get to make lots of decisions
cons	• less pay • less respect • poorer or more dangerous working conditions • smaller role in decision-making	• have to discipline employees • you get blamed and maybe fired when things aren't going well • probably not represented by a union • may get stuck in a lot of meetings

This may naturally lead into a discussion of unionism, worker's rights not to join unions, and collective bargaining.

➢ **CHRONOLOGY:**

The activity phase of Unit 8-1 can be broken into four parts:

PART I (1 day): Identify technological impacts in the surrounding community via newspapers and other media.

PART II (2 days): Field Trip: on-site observation of labor division. Almost any enterprise will do; if an off-site field trip isn't possible; perhaps visit the school cafeteria during lunch preparation. After the trip, discuss the different roles which students observed, and map out the organization of the workers. As a follow-up, have students, in groups, map out the organization of four to eight local technological enterprises, any of which may become the focus of their major grade eight project.

PART III (5-6 days): Collect and analyze data on the impact these technological endeavors have on individuals and the community. Methods may include using community electronic bulletin boards to take polls; e-mailing local officials; interviewing school staff; interviewing parents or other adults outside of school; contacting individuals identified in media reports; illustrate findings using appropriate charts, graphs, and written reports. On the final day, students should narrow the topic list down to three discrete technological problems that the class could plausibly research. Assign students to six groups: One each in favor of researching each of the three problems; on each arguing that the each of the three problems are not sufficiently great to be researched. It is important that the each of the three topics be acceptable and "doable."

PART IV (approx. 3 days): Each of the six groups should begin to plan an oral report that they will present to the class. If possible, assemble a panel of adults who can constitute an audience.

EXTENSION IDEAS FOR UNIT 8-1

HOUSEHOLD CHEMICAL WATCH...most students will acknowledge that dangerous chemicals can be found in nearly every home. In this activity they **document common household products which may pose chemical threats**. Special safety instructions should be given to the students orally as well as on paper, so that parents can help in ensuring that caution is used at all times when handling containers which hold chemicals. Students might be assigned to make a list with the following information about products that they find around their homes:

product name	common uses for the product	chemical(s) contained	precautions to be taken	environmental effects

Another direction which might be taken, and which might be of use to the class as a whole, is to have students perform this type of investigation on materials and supplies around the technology lab. Glues, paints, styrofoam, and many other products are in fact chemicals, many of which should be handled in specific ways to ensure safety. Students could then make informative posters to display around the lab and classroom...

THE ENERGY AUDIT..."energy efficiency" isn't as popular a topic as it once was, but perhaps it should be. "Energy audits" were once a very common activity in junior-high science, social studies, and industrial arts classes. Over the last thirty years, Americans have become a little more conscious about energy usage, and newer buildings have been designed, both in the materials used and the fixtures installed, to be much more efficient. Contractors still regularly conduct energy audits, however, on buildings both new and old. In this activity, **students conduct their own energy audits at home or at school**. Of course, home energy audits could be done over a period of weeks, if desired; if such time is available, extensive information is available at *http://www.ase.org/educators* and on several other web sites (just search for "energy audit"). If less time is available, this activity may be a homework assignment in which students look at home for energy-saving or energy-wasting lighting, windows, window coverings, and doors. If the various students' results are compared, care should be taken not to embarrass students who come from less fortunate homes...

UNIT 8-2: TECHNOLOGY & ECONOMICS

In this unit, students will identify a technological system to investigate. After identifying their objective and its constituent goals, they will draft a detailed plan of procedure for investigation, documentation, and reporting. Students will also establish a calendar which they will use to guide their use of the time they will be given to complete their grade eight technology challenge.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Problem identification, Investigation and research, Documentation of a technological problem

➢ **REVIEW ACTIVITIES FROM GRADES SIX AND SEVEN:**

6.3.B. Brainstorming and creativity
7.1.D. Maintenance and scheduling in transportation
7.2.D. Integration of communications and production systems
7.3.D. Organization and sequencing in production

➢ **SCHEDULE:**

DAY 21—**Instruction**: how technological and social systems interrelate. *<8.2.A. Economic organization of society; Economics, politics, and technology>*
ACTIVITY➔ students expand their previous organizational flowcharts of the three technological enterprises they are investigating. The expanded diagrams will encompass the larger place of the enterprise in society, considering its political, social, and economic relationship(s).

DAY 22—**Discussion**: students should begin to discuss how this determination should be made (if a favorite has not already emerged). *<8.2.C. Consumer demands and decisions>*
ACTIVITY➔ students continue working on their diagrams.

DAY 23—**Discussion**: the impact of technologies on people, families and neighborhoods. How many people are affected by each of the three alternatives? *<8.2.B. Societal use and distribution of resources>*
ACTIVITY➔ teacher and/or students arrive at a final decision as to the project they will undertake..
ACTIVITY➔ wrap-up work on expanded organizational flowcharts.

DAY 24—**Discussion**: the impacts of local technologies on the larger community and economy; the impacts of worldwide technologies on local communities and individuals. *<8.2.D. Global market economy and its local and technological effects>*

DAY 25—**Instruction**: developing a plan of procedure. For the rest of this unit, students will be planning for their grade eight challenge. They must identify their primary objective, goals, the steps necessary to achieve each goal, resources needed, etc.
ACTIVITY➔ students should have a clear objective as they begin this exercise. The first step in this activity is to identify the individual goals that will ensure achievement of the objective.

DAY 26, 27, 28—**ACTIVITY➔** continue to set out a plan of procedure.

DAY 29—**Discussion**: the team representing each step should report its schedule to the class. The class as a whole must then determine what alterations, if any, need to be made before establishing a calendar.

DAY 30—**Catch-up time**: this time is included in the schedule to account for lost time, or to allow the teacher flexibility in letting projects in this unit run long. If all of Unit 8-2 is completed by Day 29, the teacher should begin the grade eight challenge on page B-39.

ACTIVITY

➢ **CONTEXT:**

The class has a very important decision to make. As this unit begins, they will be comparing and contrasting three technological enterprises in an effort to decide which to focus on for their Grade Eight Challenge. By the end of the activity, the choice will be made, and students will have to draft a plan of procedure for investigating and documenting the enterprise they have chosen.

➢ **CONCEPTS:**

There are four important concepts that should be introduced during this activity:

1. **The impact of technologies on people, families and neighborhoods**. Once students have narrowed down their list of possible topics for study to three, they will require some criteria for making a final selection. One set of possible criteria is the impacts the technological endeavor has on the local community. How many people are affected by each of the three alternatives? What is the degree of that impact? It is important to focus on the impact of each technology on *individuals*, as well as the families and other social groups they comprise. Students should rank the three enterprises on the vague criterion of "which has the biggest impact on individual people?" This should not be the only criterion upon which the choice is made, but it should be a major consideration. Certainly, the enterprise ultimately selected should have a substantial impact on individuals in the community.

2. **How technological and social systems interrelate**. Almost all technology is social. To be sure, a hermit who fashions and uses stone hunting tools is a technologist. But almost every example of technology in the world today is a social endeavor. Could the internet exist without society? How about the latest high-tech car? Who would design and build it, and how would roads be constructed so that car could be driven? Where would the fuel come from? Who would repair and maintain it? Students should quickly be able to see how interrelated seemingly distinct technological systems are to each other and to societies. Economies are related as well. Consider what would happen if everyone in the U.S. stopped driving cars. A hundred thousand people in one part of Michigan would be out of work immediately. Without disposable income, communities largely populated by displaced workers could not sustain many restaurants, movie theatres, and shopping malls, so in a short time, thousands more would be out of work. If new industries did not crop up in the area soon, people would move to areas where they could find work. Meanwhile, the economies of many Middle Eastern nations would be devastated, as Americans' use of crude oil for personal automobiles accounts for millions of dollars *per day* in their gross national products. The "ripples" from the decision of Americans not to use automobiles would effect hundreds of millions of people in a very short time. Then again, imagine the positive environmental impacts if people stopped using cars!

3. **The impacts of local technologies on the larger community and economy**. Once the project is chosen, students should begin thinking about how their chosen technology impacts those outside its immediate reach. Can a flood in New England impact a truck driver in Alabama? Of course it can if the truck driver is heading to Connecticut to pick up a harvest which is threatened by foul weather. So, too, could a decision not to build a dam on a New England lake impact that same Alabaman.

   Conversely, how is the technology that the students will study impacted by external technologies? If time permits, the class could expand their organizational flowchart of the selected technology to include national, international, and global interactions.

4. **Developing a plan of procedure**. A *plan of procedure* is the foundation of many technological endeavors. As a term, it refers to a detailed and ordered list of tasks which must be accomplished in order to reach a goal. Because it is a plan, it is made to be followed, but may be modified as the procedure is carried out. By the end of this unit, students will have to have a plan of procedure for investigating and documenting the technological enterprise they will study.

   For many people, it makes the most sense to develop a plan of procedure backwards, by starting with a goal. Suppose the goal is to hold a successful surprise birthday party for a friend. The steps immediately leading up to yelling "surprise!" include getting the friend to the site without being suspicious, having all of the other guests waiting when the friend arrives, and having the site be properly decorated and furnished with food, gifts, etc. In order to get to that point, a site has to be secured; guests have to be invited, and decorations, food, and party favors need to be purchased. Another step backwards and we're considering how to select the date and time when the most people are available, as well as how to pay for the event. Backwards planning may not sound like the soundest method, but it is probably the most common, and it usually works.

   A formalized plan of procedure will identify all of the resources necessary for each step, including all materials, equipment, and supplies necessary; any materials that will be referenced, how much time and money will be required, and which people will be involved.

➢ **CHRONOLOGY:**

The activity phase of Unit 8-2 can be broken into three parts:

PART I (2 days): The students expand their previous organizational flowcharts of the three technological enterprises they are investigating. The expanded diagrams will encompass the larger place of the enterprise in society, considering its political, social, and economic relationship(s). Soon, the class will need to choose one of the three remaining alternatives. Students should begin to discuss how this determination should be made (if a favorite has not already emerged). To what degree should students use the input gathered from polls, interviews, and the feedback from those who observed the presentations given in the prior unit?

PART II (1 day): The class arrives at a final decision as to the project that they will undertake. The teacher may decide to hold a class vote to make the selection. If so desired, more than one choice can be made if the teacher is interested in having two or three teams of students working on separate projects. Alternately, one project may be chosen and teams may be assigned to focus on various aspects thereof.

PART III (4-5 days): The students should have a clear objective as they begin this exercise. The first step in this activity is to identify the individual goals that will ensure achievement of the objective. In the following days, the students should continue to set out a plan of procedure. The next steps are to identify each step needed for each goal; to identify the time and other resources required for each step; the development of a resources list; and, based on the times identified for each step, the drafting of a calendar/schedule for meeting the objective. In plan outlined in this curriculum, fifteen days are set aside for the grade eight challenge. The teacher should identify at the outset whatever time constrains will need to be imposed on the project. Once the goals are fleshed out, teams of students should be assigned to carry out the additional planning. Perhaps the each of the largest two or three goals should be assigned to a team which is concerned only with that goal; if there are a multitude of smaller goals, one team might be able to handle several. At least one small group of students should be assigned to coordinate inter-group activity.

EXTENSION IDEAS FOR UNIT 8-2

POLITICAL CONNECTIONS...an unfortunate misperception, and one which will not be shared by students who engage in this activity, is that technology has a mind of its own; or "just happens;" or is in some way out of the control of human beings. By definition, technology is designed, realized, and controlled by people—often regular people in the local community. As part of Unit 8-2, the teacher may wish to have students **use the city directory or the internet to identify technological concerns which are overseen by local governments**. These may include road work, waste management and disposal, water, traffic control, building inspection, etc. Eighth graders should recognize each of these as a technology. Students might be assigned to make a list with the following information:

name of department	description of the department's function	department head's name and title	phone number and location

Students might also brainstorm how to validate the information on the list, which members of the community might benefit from having such a list, and how it might be distributed...

COMPUTER FLOWCHARTING...a recent search of *www.download.com* using the term "flowchart" produced a total of 13 programs for IBM-PC (10 shareware) and four Macintosh flowcharting programs, all available for free download. Additional programs may be found by using different search terms (such as "organization chart"). If an internet connection is available, individual students who are a bit ahead of the class might be assigned to download and try out one or more of these packages. When a quality flowcharting program is found, you may assign students the task of **charting the flow of a particular resource (material, energy, etc.) through a technological system**. Examples may include how a paper clip, pencil, or compact disc is manufactured...

GRADE EIGHT CHALLENGE

The grade eight challenge is to identify and address a real-world problem. This project will vary from class to class and from year to year, so specific guidelines are not offered here, instead, several ideas are presented here to allow the teacher to design an experience that fits the class and their research.

This is the only activity in this curriculum for which a detailed schedule cannot be provided. This activity is recommended to begin on Day 31 of 60, meaning that up to six weeks may be devoted to this challenge. In the plan presented here, the first two weeks are set aside for conducting the investigation (all planning should be complete by this point). The third week is for planning and, schedules permitting, presenting a report to appropriate community members. The time remaining in the term is set aside for Unit 8-3 (two weeks), as well as a final, wrap-up week.

➢ **SCHEDULE:**

WEEKS 1 & 2 (DAYS 31-40)—ACTIVITY→ Part I: Conducting the study.
DAY 41, 42, 43—ACTIVITY→ Part II: Preparing a report to present to interested parties.
DAY 44, 45—**Student presentations**.

ACTIVITY

➢ **CONNECTIONS:**

Everything in the grade eight curriculum—and, indeed, in grades six and seven as well, has been building up to this project. In Unit 8-1, students have investigated the impacts of local technological enterprises. In Unit 8-2, they continued this inquiry, selecting one particular technological problem to focus on. During this fifteen-school-day period, they will document the problem, identify possible solutions, and report their findings to appropriate members of the community. Students will also assemble materials for a final report, which they will compose in Unit 8-3.

➢ **CHALLENGE:**

Here are some projects students could undertake as their grade eight challenge.

1. **Traffic control**. Students observe traffic patterns in a specified area. How many cars pass each point per hour? (if a radar gun is available from the local police department, what percentage of drivers observe the speed limit? How many pedestrians are there? Are traffic signals on a timer? Do stoplights give an appropriate amount of time to drivers in both directions? Do pedestrians have enough time to cross the street? Can a more equitable signal pattern be identified, or is the present one optimal? Are stop signs and traffic signals placed in appropriate spots? Are there *more* appropriate places for them? Are streets and sidewalks well-positioned, or should they be re-routed? Are bike paths in place? If not, should they be? And if so, how and where? In general, what steps could be taken to improve vehicular and pedestrian traffic in this area? Local public works, civil engineering, or traffic control officers could make a panel to whom a report is delivered.

2. **Caloric accuracy**. All chain restaurants are required to make nutritional information available for each of their products, including the number of calories in each menu item. But how accurate is this information? A scientific burn test (conducted, of course, under adult supervision) can determine the actual number of calories in, say, a double cheeseburger. But burning one cheeseburger won't identify the average number of calories in that menu item, not to mention that it would be time consuming! Perhaps burning samples (perhaps a 1/8 "pie piece" carefully cut and weighed) of a larger number of cheeseburgers, then averaging the results (and, in this case, multiplying by 8) would yield a more reliable result. Multiple restaurants could be compared and a report could be presented to franchise owners or regional managers.

3. **Product testing**. Does fishing line advertised as "100-lb." really have a hundred pounds of tensile strength? Does one brand of paper towel really absorb "more than the leading brand"? Can you really get 4 oz. of toothpaste out of a four-ounce tube, or are you paying for product you can't use?

Does store-brand bagged cereal really taste the same as the name-brand it is supposed to be like? (On a related note, what would happen if the "Pepsi Challenge" were conducted in the school cafeteria?) These and other questions as to the veracity of product claims can be evaluated scientifically if testing and experiments are well-planned and carefully conducted. Perhaps the local Chamber of Commerce or Better Business Bureau would be interested in the results!

4. **Water cleanliness and safety**. Probably the most tried-and-true activity of its genre, this project has students studying the ecology of a reservoir, lake, shore, or river that is commonly used for recreational purposes, and compiling a report on (a) the cleanliness of the water; (b) plant and animal life in and around the water; (c) how safe the area is for recreation; and (d) whether people observed using the area observe common water safety rules. Many tests can be performed on water samples, and these can be compared to established norms (which will have to be researched). Fresh water can also be distilled so that contaminants and additives can be isolated.

5. **Quality of life in different neighborhoods**. This could be a real eye-opener. Students visit two neighborhoods in the same town (it is very important that neighborhoods be chosen if any students or their immediate family members live there; perhaps a town not served by the school would be best). They select and measure five or six quality-of-life standards, such as traffic congestion, total ambient noise in a one-hour period (specialized equipment will need to be borrowed for this one), gasoline, grocery, and clothing prices (it's important to, if possible, price exactly the same items at two different stores in the same chain), drinking-water quality (amount of contaminants; pH level), access to parks, pools, etc. A study of this type, assuming it is of quality, should be presented to the highest civic authority in the municipality (mayor, city manager, or town council) or to a state congressperson representing both areas.

➢ **CONCEPTS:**

There are three important concepts that should be introduced at the start of this activity:

1. **The scientific method**. Researchers who use the *scientific method* observe two straightforward rules. First, they conduct their research by making hypotheses and testing them. Second, they use objective experiments to collect data.

2. **Replicability**. Simply put, *replicability* means that a study can be repeated by a second researcher with the same results.

3. **Clarity in reporting results.** Because the results of this study are going to be presented to members of the community, it is important that they be presented in a clear way. The students who work on this project, one would hope, will become experts in specific areas that some adults may know little about. It is also important to note that when students present to community members, they are not only representing themselves, but their school as well. Thus, their presentations should be serious and respectful.

➢ **CHRONOLOGY:**

The activity phase of this project can be broken into two parts:

PART I (10 days): Conducting the study. Students may require more time than this depending on the nature of their project.

PART II (5 days): Preparing and presenting a report to applicable community members. This only provides time for a brief presentation to be put together. The formal, technical report is part of Unit 8-3.

➢ **CONTINUATION:**

The integrative possibilities for this project are numerous. The grade eight challenge is no more a technology activity than it is a social studies, science, or communication arts activity. Two social studies standards that could be addressed via extension activities to this project are history (Time, Continuity, and Change, Standard II) and geography (People, Places, and Environment, Standard III).

Students could read histories of historical inventors, social activists, or other change agents and identify similarities between the subject's background, methods, results, and the reception of those results, and their own experiences in investigating an enterprise. Similarly, they could read stories set in different times and places, and then situate their own explorations in that time, place, and culture. What would be the same and different if their study were conducted in a completely different environment? What do these potential similarities and differences say about the two cultures being compared?

It should be remembered that soon, these eighth-graders will be leaving middle school and will be thinking about their futures after high school. This real-life project should give students the chance to consider the different careers available in the area which they studied, as well as other areas, related or not. Here is a convenient way of classifying careers:

	Building Trades / Construction	Health Care	Agriculture / Natural Resources
No formal educational requirements; on-the-job training	• utility laborer • materials hauling	• office assistant	• park maintenance • general farm work
Some formal training after high school	• rough framing • roofing • cabinetmaking	• food/nutrition worker • residential home assistant	• agricultural equipment repairer • welding
At least two years of formal postsecondary education (often licensed)	• mason • electrician • plumber	• nurse's assistant (CNA) • x-ray technician • Pharmacy assistant • medical records clerk	• florist • park guide • heavy equipment operator
Bachelor's degree (4+ years of college)	• industrial manager • safety examiner	• head nurse (RN, LPN) • psychologist • insurance specialist	• biologist • water inspector
Professional degree	• structural engineer • architect	• doctor • dentist	• veterinarian • farming executive

The three career fields are given as examples. All three (like most career fields) have jobs ranging from those with very little possibility of advancement to very high-paying, prestigious positions. Detailed information is available on numerous web sites with career information appropriate for eighth-graders. Students should understand that there are many career fields available to them, and that the potential for advancement depends upon the worker's attainment of at least some formal education after high school—although many high-paying jobs today do not require four-year university degrees.

UNIT 8-3: TECHNOLOGICAL IMPACTS

With this unit, students will complete their technological studies experience at Thomas Edison Middle School by comprehensively documenting their findings in a report.

➢ **TECHNOLOGY PERFORMANCE TASKS:**

Documentation of a technological problem, Development of possible solutions, Solution refinement and modeling, Presentation of solution, Development of a final report

➢ **REVIEW ACTIVITIES FROM GRADES SIX AND SEVEN:**

6.1.B. Constraints of problem-solving
6.1.D. Real-life problems and solutions
7.2.B. Acquiring and accessing electronic information
7.2.C. Design of communications systems

➢ **SCHEDULE:**

DAY 46—**Instruction**: the four primary types of technological impacts. *<8.3.A. Evaluation of expected / unexpected and wanted / unwanted affects of technology>* **ACTIVITY➔** Part I: Analyzing the data.

DAY 47—**ACTIVITY➔** Part I, continued. Students continue collecting data on topics such as the history and future of the selected technology; careers; local and societal impacts; etc. *<8.3.D. Personal, societal, economic, environmental impacts>*

DAY 48, 49—**Instruction:** the Input–Process–Output–Feedback model and its limitations. *<8.3.B. Input-Process-Output-Feedback model>* **ACTIVITY➔** Part I, continued. By now, students should be classifying their data into categories that will be included in their reports.

DAY 50—**Instruction**: the impacts of technology throughout history. *<8.3.C. History and impacts of technologies>*.

DAY 51—**Instruction**: how to design an outline; using outlining capabilities in the word processor. **ACTIVITY➔** Part II: Outlining the report.

DAY 52, 53, 54—**ACTIVITY➔** Complete Part II if necessary. Begin Part III: Students begin prepare their final reports.

DAY 55—**Discussion**: careers and further education in technology. **ACTIVITY➔** Complete Part II if necessary.

ACTIVITY

➢ **CONTEXT:**

The students have completed the single most important technological study they will undertake in middle school. During this unit—their last as middle-schoolers—eighth graders will carefully document their investigation of the technological enterprise they have finished studying. They will also consider careers in technology and what future education they may take advantage of during and after high school.

➢ **CONCEPTS:**

There are three important concepts that should be introduced during this activity. Students should consider each as they write their final reports on the enterprise that they investigated: what are the wanted and unwanted, expected and unexpected impacts of the technology they investigated? How can it be described using the universal systems (Input–Process–Output–Feedback) model? And what historical developments led to the current state of the technological enterprise? Here are some ideas for discussing these three ideas with the class.

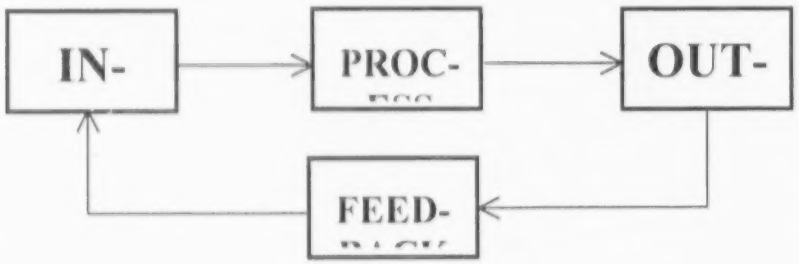
1. **The four primary types of technological impacts**. Here's a question to pose to students: what would be the impacts of building an amusement park across the street from the school? Have them brainstorm a list. Encourage them to list positive and negative impacts. When an exhaustive list has been constructed, have mark each impact as *wanted* (✓) or *unwanted* (✗). Then review the list and mark each impact as one which would have been *expected* (E) by the school or the amusement-park owners, or *unexpected* (U). It may be appropriate to allow students to add possible unexpected impacts

at this stage. The items on the impacts list could then be arranged into a matrix such as the one below.

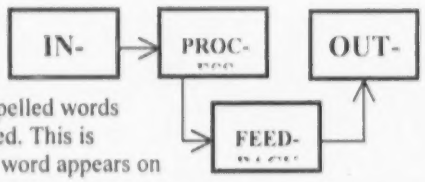
	wanted (✓)	unwanted (✗)
expected (E)	• a fun place for kids to go • lots of jobs for local people • provides entertainment unavailable elsewhere nearby • could make a lot of money for the owners	• traffic congestion near the school • might be noisy and distracting to students who are trying to learn • blocks nice mountain view
unexpected (U)	• increased tourism from bordering communities • great school field trips! • interests kids in careers in construction	• lots of trash in the neighborhood • kids going to the amusement park instead of school • families not spending time together (because kids are at amusement park)

It should be clear to students that unwanted and unexpected impacts are quite different (although some impacts are both), and that unexpected impacts are not necessarily negative impacts. On the other hand, nearly every planned technological system has at least some expected, unwanted outcomes. But for whatever reason, these negative impacts are judged to be outweighed by the expected positive outcomes of the project. This may naturally lead into a discussion of tradeoffs and choices, certainly an apropos topic for students soon to enter high school—albeit one about which they have probably heard many lectures recently!

2. **The Input–Process–Output–Feedback model and its limitations.** The simple-to-explain and oft-applicable Universal Systems Model should be understood by students to be a simplification of any real-life technological system. In its simplest form, the model looks something like this.



As the teacher may wish to say to the students, there is good news and bad news about this model. Let's start with the good news: in a general sense, the Input-Process-Output-Feedback model (IPOF) can be used to explain nearly any system, technological or not. One example is word processing on a personal computer, a communications system. The user *inputs* data via the keyboard; the keystrokes are *processed* into letters, which are *output* to the screen or printer. The user reads what appears on the screen or paper and makes edits; this *feedback* completes the loop. Consider a home heating or cooling system. Electric energy is *input* into the system; it is *processed* through a circuit that powers a heating unit; heated air flowing through the house is the *output*; a thermostat constantly measures the temperature and shuts the heating unit down when the room temperature exceeds a specified level; this is the *feedback* portion of the system.



The bad news about the IOPF model is that few systems are that simple. Sometimes feedback occurs during or immediately after the processing phase. In the word-processing example, newer software identifies misspelled words by underlining them in red immediately after they are typed. This is feedback, but it occurs *before* the output phase (when the word appears on

the screen), not after, as depicted in the first diagram. Students should be able to identify several other examples.

3. **Impacts of technology throughout history**. Some historians consider the invention of the moveable-type printing press by Johann Gutenberg in the 15th century to be the most significant technological invention ever. It's easy to see why; without printing the industrial revolution would've been heavily impeded; manuals for machines, labels for packaging, and training manuals for factory workers would not be available. Of course, without the industrial revolution, inventions of the automobile and telephone, rather than having happened more than a century ago, might only be evolving today. There would be very few libraries, and probably none would be open to the public. There would be no newspapers. There are many other examples of how a single invention created a "splash" with ripple effects felt for centuries—in agriculture, the invention of the cotton gin had tremendous social impacts. The world-wide web is still in its first decade of common use. What effects will it have in the future?

➢ **CHRONOLOGY:**

The activity phase of Unit 8-3 can be broken into three parts:

PART I (4 days): Analyzing the data. During this part of the activity, the students locate and classify all of the data they will need to have available for their final report. They may begin to draft parts of the report.

PART II (1 day): Outlining the report. Students will identify the necessary parts of the report and will begin to outline their reports in word-processing files, or in HTML for the creation of web pages. The teacher will probably want to demonstrate the basics of outlining and walk through the steps with the students. In addition to sections commonly included in science reports (problem, hypothesis, etc.), here are some technological subjects which can be integrated into the traditional science-report sections:

science sections	technological sections
Problem. Hypothesis.	Systems-description of the technology —input, process, output, feedback (from Units 8-1, 8-3). Plan of procedure (from Unit 8-2). Career and educational possibilities of the technology (from Unit 8-3).
Findings.	Division of labor observed (if applicable; from Unit 8-1). Local impacts of the technology (from Units 8-2 and 8-3). Potential societal and global implications (from Units 8-2 and 8-3). Historical connections (from Unit 8-3).
Conclusions.	Recommendations for changes in the enterprise (provide a plan of procedure and a refined systems model). Future directions for the technology.

PART III (4-5 days): Students prepare their final reports.

EXTENSION IDEAS FOR UNIT 8-3

THE ETHICS OF AUTOMATION...this extension activity will probably require three to four class periods, and may be ideal for situations in which a few students are finished with their work before most of the rest of the class. Have these students use the library or internet to research the question of how automation affects people who work in factories or in any other phase of manufacturing. Do robots take jobs away from people? Do they really do jobs that would be unsafe for humans? Does automation actually create new jobs? What happens when a person loses his or her job? The eighth-grade researchers could then provide information that their classmates might use to **debate the merits of automation in modern industry**. If only one period is available, the teacher may choose to provide a variety of viewpoints, pro and con, to the students. Each group could then be assigned to produce a brief written argument to be presented to the class...

VISUAL TECH REPORT...assuming that pictures actually do speak louder than words, this may be an ideal extension for the grade-eight challenge, or a substitute for or enrichment of Unit 8-3. Rather than simply requiring a written paper containing the students' findings from their grade-eight project, the teacher may choose to require a "visual tech report." In such a report, **students incorporate images using a disposable camera, electronic still camera, or video camera into a tech report which relies much more on pictures than words**. This extension activity will work best if it is planned before the grade-eight challenge, so that students can collect images of all phases of the project. the final product may take the form of a portfolio, web page, electronic presentation using PowerPoint, Persuasion, or similar software, or an edited videotape...

Glossary of Technical Terms

These are some of the terms introduced in the technological studies curriculum for grades 6–8. These are not all of the important words in this curriculum; this list focuses primarily on technical vocabulary. The numbers following the glossary entry indicates the grade level or levels at which the word is used.

ACID RAIN ⑧ — rain, containing human-made pollutants, which is harmful to the environment.

ALTERNATING CURRENT ⑦ — usually, the electric current available through a wall outlet, as opposed to "direct current," which is usually current supplied by a battery.

ALTERNATIVES ⑥ — different options or choices which may lead to the same goal.

AMPLIFIER ⑦ — an electronic component that increases the strength of a signal (such as a sound).

ARCHITECT ⑦⑧ — an engineer who designs or plans a structure (such as a house or building).

BRAINSTORMING ⑥ — a process through which people in a group propose alternatives to a problem. In brainstorming, all ideas are written down and none are rejected.

BUSINESS PLAN ⑧ — a list of a business's goals and methods to achieve those goals. Financial terms are also included.

CASH-FLOW ANALYSIS ⑧ — in essence, a budget for a specific time period. Includes both income and expenses.

COMMISSION ⑧ — a governmental body charged with a specific civic task. Examples of such tasks include water quality and internet policy.

COMMUNICATION SYSTEM ⑦ — any system in which a message is intentionally sent from a transmitter to a receiver.

COMMUNICATIONS ⑥ — the act of sending and receiving a message. Messages may be sent and received by people, animals, or machines.

COMPONENT ⑦ — any single piece of a larger system. For example, an antenna or satellite dish is a component in a television communications system.

CONDUCTOR ⑦ — a material which easily allows electric current to flow through it. (May also refer to a material that allows heat to flow through it.)

CONFLUENCE ⑧ — a point in a system where separate resources are combined.

CONSTRUCTION ⑦ — the act of building a structure on the site where it will stand.

CONTRACT ⑧ — a formal, legal agreement between two or more people or companies.

COORDINATION ⑧ — planning ahead so that groups of people can work on different parts of a project at the same time. (Can also mean planning so that multiple systems can work together at the same time.)

CURRENT ⑦ — the flow of electrons through a circuit.

CUSTOM-MADE ⑦ — refers to a component that is built specifically to fit into a single system. Opposite of mass production.

ELECTRIC MOTOR ⑦ — a component which uses electricity to produce circular motion.

ENERGY ⑥ — in scientific terms, energy is "the capacity to do work." Types of energy include electrical, mechanical, and thermal.

ENGINE ⑦ — any component which converts energy into motion.

ENGINEER ⑦⑧ — as a noun, a person who designs technological systems. As a verb, the act of planning or managing such systems.

ENVIRONMENT ⑧ — a person's or community's physical or social surroundings. The natural environment includes the air, land, and water. The human-made environment includes all technological systems and components.

EPA ⑧ — the Environmental Protection Agency. A government agency which is intended to ensure that businesses comply with laws which protect the environment.

ERGONOMICS ⑧ — the technique of making products which are safe and comfortable for people to use.

ESTIMATOR ⑦ — a person whose job it is to estimate how much a project will cost.

FEEDBACK ⑥ — information from a user of a system which helps improve the system's operation. Also, the use of this information.

FUSION ⑧ — (a.) the act of bringing together two ideas or systems to create a single, new idea or system.
(b.) the act of producing energy by combining atomic nuclei.

FUTURING ⑧ — planning or projecting which takes current and future trends into consideration.

GENERAL CONTRACTOR ⑧ — a person who coordinates a large construction project.

GRAPHIC COMMUNICATION ⑦ — that branch of communication that involves messages composed of written or printed symbols or images.

IMPACT ⑧ — in technology, an impact is the effect that a system has on people, the environment, or other systems. Impacts may be wanted or unwanted; expected or unexpected.

INFORMATION ⑥ — any signal communicated among people, machines, or animals.

INPUT ⑥ — any technological resource that is put into a system.

INTELLIGENT BUILDINGS ⑧ — houses or other structures constructed with integrated environmental, communications, security, and other systems.

INTERCHANGEABLE ⑦ — refers to components that can be substituted for each other. For example, most standard lightbulbs are interchangeable.

INTERNAL COMBUSTION ENGINE ⑦ — generally, an engine which burns gasoline or some other fuel in an enclosed container in order to operate.

ISOMETRIC ⑦ — a type of drawing in which three dimensions of an object are drawn. In isometric drawing, all dimensions are drawn in actual size, as opposed to perspective drawing, in which objects are shown receding into the distance.

JUST-IN-TIME MANUFACTURING ⑦ — a manufacturing system in which materials are delivered and products are produced are only when needed. In theory, just-in-time manufacturing operations should not require storage of manufactured parts.

KINETIC ENERGY ⑦ — the energy an object has when it is moving.

MACHINES ⑥ — a mechanical resource which changes the amount, direction, or speed of an object or force.

MAGNETIC LEVITATION ⑧ — the use of magnetism to reduce friction in a transportation system.

MANUFACTURING ⑥⑦ — any technological system in which products are made.

MARINE ⑦ — in transportation, a system of moving people or goods across or under the water. Also, that part of the environment involving the sea.

MASS PRODUCTION ⑥⑦ — a manufacturing system designed to produce a large number of interchangeable products.

MATERIAL ⑥ — a physical resource which is an input to a manufacturing or construction system.

MODEL ⑥ — a pattern of a system which is being planned. A model is often used for testing purposes.

NOISE ⑦ — in a communications system, any unwanted part of a message or signal.

OSHA ⑧ — the Occupational Safety and Health Administration. A government agency charged with protecting the health and safety of workers in many technological jobs.

OUTPUT ⑥ — any technological resource that is produced by a system.

OVERRUNS ⑧ — (a.) costs of a project that exceed estimates.
(b.) products are intentionally manufactured as extras or spare parts.

PERSONAL RAPID TRANSIT ⑧ — a transportation system designed to carry a small number of passengers (usually 1-4) along an elevated pathway.

POLLUTION ⑧ — any output of a technological system which has a negative impact on people or the environment. "Pollutants" are small particles which pollute air or water.

POTENTIAL ENERGY ⑦ — any energy stored in an object has when it is at rest.

PROBLEM SOLVING ⑥ — using a process to attempt to solve a problem or address a need.

PRODUCTION ⑦ — the act of using machines and materials to manufacture or construct an item or items.

PROPELLER ⑦ — in a transportation system, a mechanical component which uses rotary motion to move a vehicle.

PROTOTYPE ⑦ — a model that is built as a test before the actual item is made.

RECEIVER ⑦ — in a communications system, a component which accepts a message. May also refer to a person, machine, or animal that receives a message.

RESEARCH ⑥ — a process used by people to obtain information about a particular subject.

RESOURCES ⑥ — any or all of the things needed by a technological system to make it work. Important resources include people, materials, machines, energy, and money.

ROBOT ⑦ — a mechanical component that does the work of a human laborer. Robots are often used to do tedious or dangerous jobs.

SPECIFICATIONS ⑦ — the requirements engineers or architects use when planning a project.

STRUCTURE ⑦ — any item which is constructed. Examples include houses and other buildings; bridges, railroad tracks, and roads; etc.

SUBCONTRACTOR ⑧ — a person or business (usually in the construction field) whose work is coordinated by a general contractor.

SUBSYSTEM ⑥ — a group of components which operate together as a small system. This small system is itself part of a larger system.

SYSTEM ⑥ — a group of components which uses resources to achieve a goal. Systems include inputs, processing, outputs, and usually, feedback.

TECHNICAL DRAWING ⑦ — a form of graphic communication which gives the receiver exact information about an item's size and shape.

TECHNOLOGY; TECHNOLOGICAL ⑥ — any method used by people to process materials to meet their goals and objectives. Also used to refer to practical human knowledge.

TRADE-OFF ⑥ — an alternative which includes both wanted and unwanted impacts.

TRANSISTOR ⑦ — an electrical component which controls the amount of current in part of an electrical system.

TRANSMITTER ⑦ — in a communications system, a mechanical or electrical component which sends a message. May also refer to a person, machine, or animal that sends a message.

TRIAL AND ERROR ⑥ — a problem-solving process in which various solutions are tried until the problem is solved.

UNION ⑦ — a group of workers who negotiate their pay, work hours, and other conditions with their employer.

VENTURE CAPITAL ⑧ — usually refers to money that is used to start up a new company. A "venture capitalist" generally receives some control of the company in exchange for his or her investment.

VOLTAGE ⑦ — the force of the electrical current in a system.

WORK ⑦ — the output of a mechanical system that results in the movement of a material or an item.

ZONING ⑧ — the act of setting aside parcels of land for specific purposes, such as residences, commerce, manufacturing, etc.

This is a three-year technological studies curriculum that integrates studies of science, technology, and society. Professionals in each of these three areas have developed national curriculum standards: the National Science Education Standards *(National Research Council, 1996); the* Standards for Technological Literacy *(International Technology Education Association, 2000), and* Expectations of Excellence: Curriculum Standards for Social Studies *(National Council for the Social Studies, 1994). While the Thomas Edison Technological Studies curriculum is not designed to embody every middle-school standard in each of these documents, it may be instructive to designate which national standards are addressed by each of the curriculum's nine major units.*

National Social-Studies Standards

Due to their specificity, the middle-grades **Curriculum Standards for Social Studies (NCSS, 1994)**, are primarily correlated with the units which make up grade 8—the most socially oriented of the three. The first unit of grade six and the last of grade seven also exhibit direct ties to social-studies standards:

Thomas Edison technological studies unit	Middle-grades Curriculum Standards for Social Studies (NCSS, 1994)
UNIT 6-1: Problem-Solving/Research & Design	
6.1.A. Problem-solving identification and terminology	I. CULTURE: a. Compare similarities and differences in the ways groups, societies, and cultures meet human needs and wants.
6.1.B. Constraints of problem-solving	V. INDIVIDUALS, GROUPS, AND INSTITUTIONS: g. Apply knowledge of how groups and institutions work to meet individual needs and promote the common good. VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: f. explain and illustrate how values and beliefs influence different economic decisions.
6.1.C. Applied Research	II. TIME, CONTINUITY, AND CHANGE: d. Identify and use processes important to reconstructing and reinterpreting the past, such as using a variety of sources…weighing evidence for claims, checking credibility of sources… IV. INDIVIDUAL DEVELOPMENT AND IDENTITY: h. Work independently and cooperatively to accomplish goals.
6.1.D. Real-life problems and solutions	III. PEOPLE, PLACES, AND ENVIRONMENTS: g. describe how people create places that reflect cultural values and ideals as they build neighborhoods, parks, shopping centers, and the like. VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: a. Examine and describe the influence of culture on scientific and technological choices and advancement, such as in transportation…
UNIT 7-3: Production Systems	
7.3.A. Production terms; craft, line assembly, automation	II. TIME, CONTINUITY, AND CHANGE: c. Identify and describe selected historical periods and patterns of change within and across cultures, such as…the development of transportation systems… VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: i. Use Economic concepts to help explain historical and current developments and issues…
7.3.C. Model design and realization	III. PEOPLE, PLACES, AND ENVIRONMENTS: d. estimate distance, calculate scale, and distinguish other geographic relationships… III. PEOPLE, PLACES, AND ENVIRONMENTS: g. describe how people create places that reflect cultural values and ideals as they build neighborhoods, parks, shopping centers, and the like.
UNIT 8-1: Enterprises and Agencies	
8.1.A. Evolution, classification of enterprise	II. TIME, CONTINUITY, AND CHANGE: f. Use knowledge of facts and concepts drawn from history… X. CIVIC IDEALS AND PRACTICES: e. Explain and analyze various forms of citizen action that influence public policy decisions.

Thomas Edison technological studies unit	Middle-grades Curriculum Standards for Social Studies (NCSS, 1994)
8.1.C. Market and customer research	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: b. Explain the role that supply and demand…play in determining what is produced and distributed… X. CIVIC IDEALS AND PRACTICES: g. Analyze the influence of diverse forms of public opinion on…decision making.
8.1.D. Labor and management roles	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: e. Describe the role of specialization…in the economic process. VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: d. Explain the need for laws and policies to govern scientific and technological applications, such as the safety and well-being of workers…
UNIT 8-2: Economics	
8.2.A. Economics, politics, and technology	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: f. Explain and illustrate how values and beliefs influence economic decisions.
8.2.B. Societal use, distribution of resources	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: a. Give and explain examples of ways that economic systems structure choices about how goods and services are to be produced and distributed.
8.2.C. Consumer demands and decisions	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: b. Explain the role that supply and demand…play in determining what is produced and distributed…
8.2.D. Global market economy, local and technological effects	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: d. Describe a range of examples of the various institutions that make up economic systems…
UNIT 8-3: Technological Impacts	
8.3.A. Expected, unexpected, wanted, unwanted effects	VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: a. Examine and describe the influence of culture on scientific and technological choices and advancement, such as in transportation… IX. GLOBAL CONNECTIONS: d. Explore the causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues…
8.3.B. Input-Process-Output-Feedback model	
8.3.C. History, impacts of automation and miniaturazation	II. TIME, CONTINUITY, AND CHANGE: c. Identify and describe selected historical periods and patterns of change within and across cultures, such as…the development of transportation systems… VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: i. Use Economic concepts to help explain historical and current developments and issues… VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: a. Examine and describe the influence of culture on scientific and technological choices and advancement, such as in transportation… VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: b. Show through specific examples how science and technology have changed people's perceptions of the social and natural world… VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: c. Describe examples in which values, beliefs, and attitudes have been influenced by new scientific and technological knowledge, such as the invention of the printing press…
8.3.D. Personal, societal, economic, environmental impacts	VII. PRODUCTION, DISTRIBUTION, AND CONSUMPTION: j. Use economic reasoning to compare different proposals for dealing with a contemporary social issue… VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: d. Explain the need for laws and policies to govern scientific and technological applications, such as the safety and well-being of workers… VIII. SCIENCE, TECHNOLOGY, AND SOCIETY: e. Seek reasonable end ethical solutions to problems that arise when scientific advancements and social norms or values come into conflict. IX. GLOBAL CONNECTIONS: d. Explore the causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues…

National Science Standards

The units which comprise grades 6 and 8 have the strongest and most diverse connections to the **National Science Content Standards 5-8 (NCR, 1996)**, although several are found in grade 7 as well:

Thomas Edison technological studies unit	National Science Content Standards 5-8 (NCR, 1996)
UNIT 6-1: Problem-Solving/ Research & Design	
6.1.A. Problem-solving identification and terminology	A. SCIENCE AS INQUIRY: 1. Identify questions that can be answered through scientific investigations. E. SCIENCE AND TECHNOLOGY: 1. Identify appropriate problems for technological design.
6.1.B. Constraints of problem-solving	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society.
6.1.C. Applied Research	A. SCIENCE AS INQUIRY: 5. Think Critically and logically to make the relationships between evidence and explanations. E. SCIENCE AND TECHNOLOGY: 5. Communicate the process of technological design.
6.1.D. Real-life problems and solutions	A. SCIENCE AS INQUIRY: 1. Identify questions that can be answered through scientific investigations. A. 6. Recognize and analyze alternative explanations and predictions. E. SCIENCE AND TECHNOLOGY: 1. Identify appropriate problems for technological design. E. 3. Implement a proposed design. E. 4. Evaluate completed technological designs or products. E. 5. Communicate the process of technological design. F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society.
UNIT 6-2: Materials and Processes	
6.2.A. Types and uses of materials	B. PHYSICAL SCIENCE: 1. Properties and changes in properties in matter.
6.2.B. Layout and shaping	B. PHYSICAL SCIENCE: 1. Properties and changes in properties in matter. B. 2. Motions and forces. B. 3. Transfer of energy. E. SCIENCE AND TECHNOLOGY: 3. Implement a proposed design.
6.2.C. Assembly and finishing techniques	B. PHYSICAL SCIENCE: 1. Properties and changes in properties in matter.
6.2.D. Troubleshooting and testing	E. SCIENCE AND TECHNOLOGY: 4. Evaluate completed technological designs or products.
UNIT 6-3: Engineering Design	
6.3.A. Elements of electronics-engineering design	E. SCIENCE AND TECHNOLOGY: 2. Design a solution or product.
6.3.B. Brainstorming and creativity	E. SCIENCE AND TECHNOLOGY: 1. Identify appropriate problems for technological design.
6.3.C. Basic schematic sketching	E. SCIENCE AND TECHNOLOGY: 5. Communicate the process of technological design.
6.3.D. Production layout	E. SCIENCE AND TECHNOLOGY: 2. Design a solution or product. E. 3. Implement a proposed design. E. 5. Communicate the process of technological design.
UNIT 7-1: Transportation Systems	
7.1.B. Transportation design: propulsion, control, etc.	B. PHYSICAL SCIENCE: 2. Motions and forces. B. 3. Transfer of energy. E. SCIENCE AND TECHNOLOGY: 2. Design a solution or product.
7.1.C. Modes of transport: marine, space, land, air	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments.

Thomas Edison technological studies unit	National Science Content Standards 5-8 (NCR, 1996)
UNIT 7-2: Communications Systems	
7.2.B. Acquiring and applying electronic information	B. PHYSICAL SCIENCE: 3. Transfer of energy. F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society.
7.2.C. Design of communication systems	E. SCIENCE AND TECHNOLOGY: 2. Design a solution or product.
UNIT 7-3: Production Systems	
7.3.B. Methods, tools, materials in manufacturing	B. PHYSICAL SCIENCE: 1. Properties and changes in properties in matter. B. 2. Motions and forces.
7.3.C. Model design and realization	E. SCIENCE AND TECHNOLOGY: 2. Design a solution or product. E. 3. Implement a proposed design. E. 4. Evaluate completed technological designs or products. E. 5. Communicate the process of technological design.
7.3.D. Basic production organization and sequencing	E. SCIENCE AND TECHNOLOGY: 3. Implement a proposed design.
UNIT 8-1: Enterprises and Agencies	
8.1.A. Evolution, classification of enterprise	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society. G. HISTORY AND NATURE OF SCIENCE: 3. History of science.
8.1.C. Market and customer research	A. SCIENCE AS INQUIRY: 3. Use appropriate tools and techniques to gather, analyze, and interpret data. A. 4. Develop descriptions, explanations, predications, and models using evidence. A. 7. Communicate Scientific procedures and explanations.
8.1.D. Labor and management roles	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society.
UNIT 8-2: Economics	
8.2.A. Economics, politics, and technology	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments. F. 4. Risks and benefits. F. 5. Science and technology in society.
8.2.B. Societal use, distribution of resources	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments. F. 5. Science and technology in society.
8.2.C. Consumer demands and decisions	E. SCIENCE AND TECHNOLOGY: 4. Evaluate completed technological designs or products. F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 5. Science and technology in society.
8.2.D. Global market economy, local and technological effects	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments. F. 3. Natural hazards. F. 4. Risks and benefits. F. 5. Science and technology in society.
UNIT 8-3: Technological Impacts	
8.3.A. Expected, unexpected, wanted, unwanted effects	F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments. F. 3. Natural hazards. F. 4. Risks and benefits.
8.3.B. Input-Process-Output-Feedback model	E. SCIENCE AND TECHNOLOGY: 4. Evaluate completed technological designs or products. E. 5. Communicate the process of technological design.
8.3.C. History, impacts of automation and miniaturazation	G. HISTORY AND NATURE OF SCIENCE: 1. Science as a human endeavor. G. 3. History of science.

Thomas Edison technological studies unit	National Science Content Standards 5-8 (NCR, 1996)
8.3.D. Personal, societal, economic, environmental impacts	C. LIFE SCIENCE: 4. Populations and ecosystems. D. EARTH AND SPACE SCIENCE: 1. Structure of the Earth system. E. SCIENCE AND TECHNOLOGY: 4. Evaluate completed technological designs or products. F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 2. Populations, resources, and environments. F. 3. Natural hazards. F. 4. Risks and benefits. F. 5. Science and technology in society.

National Science Content Standards (grades 5-8) not specifically addressed in this curriculum:

A. SCIENCE AS INQUIRY: 2. Design and conduct a scientific investigation.
A. SCIENCE AS INQUIRY: 8. Use mathematics in all aspects of scientific inquiry.
C. LIFE SCIENCE: 1. Structure and function in living systems.
C. LIFE SCIENCE: 2. Reproduction and heredity.
C. LIFE SCIENCE: 3. Regulation and behavior.
C. LIFE SCIENCE: 5. Diversity and adaptations of organisms.
D. EARTH AND SPACE SCIENCE: 2. Earth's history.
D. EARTH AND SPACE SCIENCE: 3. Earth in the solar system.
F. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES: 1. Personal health.
G. HISTORY AND NATURE OF SCIENCE: 2. Nature of science.

Technology Education Standards

The International Technology Education Association (2000) has identified twenty **Standards for Technological Literacy**. Each is applicable at all grade levels. Nearly every unit in this curriculum has substantial ties to more than one of the ITEA standards. All twenty ITEA standards are addressed in this curriculum.

Thomas Edison technological studies unit	Standards for Technological Literacy (ITEA, 2000)
UNIT 6-1: Problem-Solving/ Research & Design	
6.1.A. Problem-solving identification and terminology	1. NATURE OF TECHNOLOGY: The characteristics and scope of technology. 3. NATURE OF TECHNOLOGY: The relationships among technologies and the connections between technology and other fields. 8. DESIGN: The attributes of design.
6.1.B. Constraints of problem-solving	10. DESIGN: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
6.1.D. Real-life problems and solutions	4. TECHNOLOGY AND SOCIETY: The cultural, social, economic, and political effects of technology. 6. TECHNOLOGY AND SOCIETY: The role of society in the development and use of technology.
UNIT 6-2: Materials and Processes	
6.2.A. Types and uses of materials	8. DESIGN: The attributes of design. 9. DESIGN: Engineering design.
6.2.B. Layout and shaping	19. THE DESIGNED WORLD: Manufacturing technologies.
6.2.C. Assembly and finishing techniques	12. ABILITIES FOR A TECHNOLOGICAL WORLD: Use and maintain technological products and systems.
6.2.D. Troubleshooting and testing	10. DESIGN: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
UNIT 6-3: Engineering Design—9. DESIGN: Engineering design.	
6.3.A. Elements of electronics-engineering design	2. NATURE OF TECHNOLOGY: The core concepts of technology. 8. DESIGN: The attributes of design.
6.3.B. Brainstorming and creativity	10. DESIGN: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
6.3.C. Basic schematic sketching	17. THE DESIGNED WORLD: Information and communication technologies.
6.3.D. Production layout	16. THE DESIGNED WORLD: Energy and power technologies. 17. THE DESIGNED WORLD: Information and communication technologies. 19. THE DESIGNED WORLD: Manufacturing technologies.
UNIT 7-1: Transportation Systems—18. THE DESIGNED WORLD: Transportation technologies.	
7.1.A. Transportation classification, terminology	2. NATURE OF TECHNOLOGY: The core concepts of technology.
7.1.B. Transportation design: propulsion, control, etc.	8. DESIGN: The attributes of design. 9. DESIGN: Engineering design. 11. ABILITIES FOR A TECHNOLOGICAL WORLD: Apply the design process. 16. THE DESIGNED WORLD: Energy and power technologies.
7.1.C. Modes of transport: marine, space, land, air	2. NATURE OF TECHNOLOGY: The core concepts of technology.
7.1.D. Maintenance, scheduling in transportation systems	12. ABILITIES FOR A TECHNOLOGICAL WORLD: Use and maintain technological products and systems. 16. THE DESIGNED WORLD: Energy and power technologies.
UNIT 7-2: Communications Systems—17. THE DESIGNED WORLD: Information and communication technologies.	
7.2.A. Communications terminology; mass, interpersonal	2. NATURE OF TECHNOLOGY: The core concepts of technology.
7.2.B. Acquiring and applying electronic information	12. ABILITIES FOR A TECHNOLOGICAL WORLD: Use and maintain technological products and systems.
7.2.C. Design of communication systems	8. DESIGN: The attributes of design. 9. DESIGN: Engineering design.

Thomas Edison technological studies unit	Standards for Technological Literacy (ITEA, 2000)
	11. ABILITIES FOR A TECHNOLOGICAL WORLD: Apply the design process.
7.2.D. Integration of communication and production	3. NATURE OF TECHNOLOGY: The relationships among technologies and the connections between technology and other fields. 19. THE DESIGNED WORLD: Manufacturing technologies. 20. THE DESIGNED WORLD: Construction technologies.
UNIT 7-3: Production Systems—19. THE DESIGNED WORLD: Manufacturing technologies.	
7.3.A. Production terms; craft, line assembly, automation	2. NATURE OF TECHNOLOGY: The core concepts of technology. 16. THE DESIGNED WORLD: Energy and power technologies. 20. THE DESIGNED WORLD: Construction technologies.
7.3.B. Methods, tools, materials in manufacturing	9. DESIGN: Engineering design.
7.3.C. Model design and realization	9. DESIGN: Engineering design. 10. DESIGN: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. 11. ABILITIES FOR A TECHNOLOGICAL WORLD: Apply the design process.
7.3.D. Basic production organization and sequencing	8. DESIGN: The attributes of design. 9. DESIGN: Engineering design. 11. ABILITIES FOR A TECHNOLOGICAL WORLD: Apply the design process. 12. ABILITIES FOR A TECHNOLOGICAL WORLD: Use and maintain technological products and systems.
UNIT 8-1: Enterprises and Agencies	
8.1.A. Evolution, classification of enterprise	1. NATURE OF TECHNOLOGY: The characteristics and scope of technology. 7. TECHNOLOGY AND SOCIETY: The influence of technology on history.
8.1.B. Organization of enterprises	2. NATURE OF TECHNOLOGY: The core concepts of technology.
8.1.C. Market and customer research	4. TECHNOLOGY AND SOCIETY: The cultural, social, economic, and political effects of technology.
UNIT 8-2: Economics—4. TECHNOLOGY AND SOCIETY: The cultural, social, economic, and political effects of technology.	
8.2.A. Economics, politics, and technology	6. TECHNOLOGY AND SOCIETY: The role of society in the development and use of technology.
8.2.B. Societal use, distribution of resources	13. ABILITIES FOR A TECHNOLOGICAL WORLD: Assess the impacts of products and systems.
8.2.D. Global market economy, local and technological effects	5. TECHNOLOGY AND SOCIETY: The effects of technology on the environment. 6. TECHNOLOGY AND SOCIETY: The role of society in the development and use of technology.
UNIT 8-3: Technological Impacts—4. TECHNOLOGY AND SOCIETY: The cultural, social, economic, and political effects of technology.	
8.3.A. Expected, unexpected, wanted, unwanted effects	5. TECHNOLOGY AND SOCIETY: The effects of technology on the environment. 6. TECHNOLOGY AND SOCIETY: The role of society in the development and use of technology.
8.3.B. Input-Process-Output-Feedback model	2. NATURE OF TECHNOLOGY: The core concepts of technology. 10. DESIGN: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. 11. ABILITIES FOR A TECHNOLOGICAL WORLD: Apply the design process
8.3.C. History, impacts of automation and miniaturazation	3. NATURE OF TECHNOLOGY: The relationships among technologies and the connections between technology and other fields. 7. TECHNOLOGY AND SOCIETY: The influence of technology on history. 13. ABILITIES FOR A TECHNOLOGICAL WORLD: Assess the impacts of products and systems.
8.3.D. Personal, societal, economic, environmental impacts	5. TECHNOLOGY AND SOCIETY: The effects of technology on the environment. 14. THE DESIGNED WORLD: Medical Technologies. 15. THE DESIGNED WORLD: Agricultural and related biotechnologies.

General Safety Guidelines

Here are the basic safety categories for the technology education lab and classroom. They are meant to supplement basic safety rules for all school facilities. Common sense dictates that learning areas be clean, that furniture be sturdy, etc. The following items are based in part on the most recent edition of **Safety and Health for Industrial/Vocational Education** *(OSHA, 1981).*

ILLUMINATION AND COLOR: All laboratory areas need to have adequate illumination. Hazard areas should be uniformly identified using specific colors (red is the accepted standard). Product manufacturers should identify illumination requirements and potential hazards in product manuals.

➢**What the teacher should do**: Be sure that product manuals are available in the lab or on file in a central location in the school, and that all areas would appear to a reasonable person to be sufficiently illuminated.

FIRE PROTECTION: Teachers need the ability to protect against, detect, and extinguish fires in the lab or classroom. Combustible and other hazardous materials should be stored in fireproof-certified containers, cabinets, or rooms. Fire extinguishers and detectors/alarms need to be appropriately placed, maintained, and regularly tested. As is the case with all safety areas, an emergency plan should be in place in case of fire.

➢**What the teacher should do**: Firefighting equipment should meet district standards in both quantity and quality. All such equipment must be in working condition. In accordance with local district policy, fire exits should be clearly identified; all students should be instructed in the proper response to a fire; and clear paths should exist to all fire exits.

HEALTH HAZARDS: These fall into the following general areas: biological, physical, radiation, mechanical vibration, and noise. In general, these hazards are either from machines or from substances used in the lab.

➢**What the teacher should do**: A Materials Safety Data Sheet (MSDS) is required to be on file for each potentially hazardous substance used in the lab. In practice, this means that if a MSDS is available for the substance, it must be available to anyone requesting it. However, many common chemicals such as paints, adhesives, and solvents, are relatively safe, and therefore their packaging contains all pertinent material safety data (application, cleanup, accidental ingestion, etc.). If any significant health risks are involved with a product without an MSDS, this packaging or the information it contains should be available. In the case of machines or other devices used in the lab which may produce dangerous levels of noise, particulants, or other hazards, the product manual (or safety manual, if one exists) should be on file. In all cases of substances or machines used by students, the instructor should be familiar with all safety precautions noted in all documentation, and should implement all safety recommendations contained therein. It should be noted that product manuals and MSDS's are filed according to district policy. Therefore, the teacher should only be expected to have this documentation readily available if this record-keeping responsibility is assigned specifically by the school district to the teacher. Otherwise, the teacher should have regular access to this information.

PERSONAL PROTECTIVE EQUIPMENT: Depending on the type of machines or substances used in class, students may require protection for their heads, eyes, or face; hearing or respiration; or body, limbs, hands, etc. As was the case with potential health hazards, equipment manuals contain safety recommendations specific to each piece of equipment, and MSDS's contain this information for potentially dangerous substances.

➢**What the teacher should do**: Personal protective equipment—specifically safety goggles or glasses in most technology education lab situations—should be in good shape and readily available to any students who need it. The teacher should inform the students as to the protective equipment required in each area of the lab.

MACHINE GUARDING: The goal of machine-guard use is essentially the same as that of the use of personal protective equipment. The primary difference is that machine guards are attached to the machine, while personal protective equipment is attached to the person. Again, equipment and machine manuals are the appropriate places to look for documentation as to the specific guards that should be available. Equipment manufacturers will usually be overcautious in their safety recommendations because this protects them from potential litigation.

➢**What the teacher should do**: As is the case with required personal protective equipment and potential health hazards, the manual of each tool, machine, or other piece of equipment will contain information about appropriate guards for that equipment. The teacher should be familiar with all manufacturers' guard recommendations, and all appropriate guards should be available for student use. Students should also be instructed in the use of all guards that they may need. It is important to note that one operation performed on a machine may require a guard, while that

same guard may actually be dangerous on the same machine during a different operation. Therefore, the appropriate machine guard—if any—may depend on the circumstances of the operation and should be determined by the teacher. Guards need not be the originals that were packaged with the equipment and may be retrofitted or custom-made by the teacher as long as they safely perform their intended function.

ELECTRICAL SAFETY: The primary hazards associated with electricity are burns, electrocution, fire, falls, and shock. Proper installation, inspection and maintenance of electrical equipment greatly minimize the risk of these hazards during regular operation. The school district is required, per the National Electrical Code, to clearly label all disconnecting circuit panels and breakers. The instructor should be familiar with the location of all circuit breakers and have immediate access to each. Students should be instructed in electrical safety, as well as in the correct use of electrical equipment.

➢ **What the teacher should do**: Generally, all electrical equipment in a school laboratory should be grounded. Only expert electricians should install or repair this equipment. If you are uncertain about the condition of any equipment or circuit in your lab or classroom, you should insist that a school or district representative conduct an inspection.

Reference Texts

Implementing this curriculum does not require the use of a textbook. Yet the topics of this technology curriculum—especially technical content—require the teacher to have on hand reference materials. Four of the most popular textbooks in general technology education are examined here to identify their usefulness as supplementary or reference materials for this curriculum.

Technology Education Textbooks

A) ***Design and Problem-Solving on Technology*** by John Hutchinson and John Karsnitz (New Jersey). Published by I.T.P. / Delmar. First appeared in 1994 as interest in "Design & Technology" curricula from the United Kingdom was at its peak in the U.S. Ultimately takes a technical design-and-engineering approach but couches technological problems in human terms—and does this better than many texts. Written for high-schoolers, this text should make a good reference book for middle-school teachers. Contains several useful appendices and a unique chapter on the artistic aspects of design documentation.

B) ***Living with Technology***, by Michael Hacker and Robert Barden (New York). Published by Delmar. The first popular middle-school text to emerge as the field was moving away from "industrial arts," its first edition appeared in 1988. Organized in the now-traditional communications—production—energy & transportation mold, its strength is in putting technical information into understandable language. This text could be a useful supplement to technology-activity books and texts that take a more societal approach.

C) ***Technology***, by Brad and Terry Thode (Idaho). Published by Delmar. Terry and Brad Thode are probably the best-known elementary- and middle-school technology teachers in the U.S., and their emphasis in print is similar to their classroom approach: the use of up-to-date, high-technology to interest and engage the learner. Designed to be used with an accompanying "Barcode-driven Technology Laserdisc," this book (originally published in 1994) contains most of the traditional technology-education content, but does not clump it into clusters. Instead, it uses academic areas (math, science, etc.) to suggest connections between the areas of technology. Contains many "design-brief" activities a teacher may use or modify.

D) ***Understanding Technology***, by R. Thomas Wright (Indiana) and Howard Smith (Illinois). Published by Goodheart/Willcox. In the first edition of this book (1989), two of the most seasoned authors in the field organized technology-education content into a model suggested by Paul DeVore in the 1960s. The technical content for each technological system (Manufacturing, Communications, Construction, and Transportation) is solid, but separated from related social content, which is in a different section of the book. The individual chapters should be good supplementary reading for eighth-graders.

Reference Crosswalk

Grade 6—Hutchinson & Karsnitz (A) provide the most complete information for the topics which comprise the grade 6 curriculum. Thode & Thode (C) offer a diversified look at the design and engineering process.

	A	B	C	D
UNIT 6-1: Problem-solving/ Research and Development	Chapters 2, 3, 10; Appendix B	Chapters 3		
UNIT 6-2: Materials and Processes	Chapters 11, 12; Appendices A, C	Chapters 2	Chapter 5	Chapters 2, 3
UNIT 6-3: Engineering Design	Chapters 4, 5		Chapters 1, 4, 6, 7, 10	Chapter 7

Grade 7—Wright & Smith (D) provide the most straightforward technical facts, although much of the same information is available in the other books, albeit in different forms. Hutchinson & Karsnitz (A) take a more design-based view of the technological systems.

	A	B	C	D
UNIT 7-1: Transportation Systems	Chapters 7, 9	Chapters 13, 14, 15	Chapters 11, 12	Chapters 4, 11
UNIT 7-2: Communications Systems	Chapters 8	Chapters 4, 5, 6, 7	Chapters 3, 13	Chapters 5, 10
UNIT 7-3: Production Systems	Chapters 6, 13 (section 1)	Chapters 8, 9, 10, 11		Chapters 8, 9

Grade 8—No one text provides a complete picture of the topics in the grade 8 curriculum. Thode & Thode (C) give the issues of economics and impacts the most thought.

	A	B	C	D
UNIT 8-1: Enterprises and Agencies	Chapter 13 (section 2)			Chapter 6
UNIT 8-2: Economics			Chapters 8, 9	
UNIT 8-3: Technological Impacts	Chapter 1	Chapter 16	Chapters 2, 14, 16	